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[656]

Competition by roads, waterways and airways.

(*Continuation*) (1).

Great Britain.

By courtesy of the British Railway Clearing House, we publish hereafter a memorandum of the British Railway Companies showing developments in regard to competition and co-ordination between road and rail during the year 1934.

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LEGISLATION.

Road Traffic Act, 1930.

a) The object of the Road Traffic Act, 1930, was to control the movement of traffic on the roads and to provide for the licensing of public service vehicles; to secure the co-ordination of the various forms of passenger road transport, with the object of obtaining the best and most economical public service.

b) Prior to the passing of the Act, the legal maximum speed limit was 20 miles per hour, but in practice this limit was ignored. The Act provides certain speed limits for various types of mechanically-propelled vehicles (e. g., 30 m. p. h. for a motor coach).

c) Prior to the passing of the Act, there was no regulation of the hours of duty or conditions of service of the drivers of public service vehicles (i.e., motor omnibuses and coaches) and commercial road motor vehicles.

Under Section 19 of the Act, it is provided that no person may drive or cause or permit any person employed by him or subject to his orders, to drive a motor vehicle :

I. — For any continuous period of more than 5 1/2 hours; or

II. — For continuous periods amount-

(1) See *Bulletin of the Railway Congress*, June 1934 to April 1935.

ing in the aggregate to more than 11 hours in any period of 24 hours commencing two hours after midnight; or

III. — So that the driver has not at least 10 consecutive hours for rest (2) in any period of 24 hours calculated from the commencement of any period of driving.

N. B. — Nine consecutive hours of rest is permissible provided twelve consecutive hours of rest is obtained in the next period of 24 hours.

The Ministry of Transport is empowered to vary these Regulations.

Under the powers granted by the Act, an order has been issued by the Minister of Transport authorising drivers of goods vehicles operating under « A » and « B » licences (3) :

a) To drive continuously for a period of eight hours if they are only on duty for one period not exceeding eight hours in a day and if they have at least an aggregate of 40 minutes' rest, of which a period of not less than 20 minutes must be taken between two and five hours after the time at which they begin their eight hours' period of duty.

b) In the case of drivers engaged by the week, to drive for 12 hours in all on two days a week if some part of the 12 hours is spent in waiting or loading or unloading a vehicle, and one complete day's rest is allowed in each week.

This order came into force on the 1st January, 1935, but does not apply to drivers of goods vehicles operating under « C » licences (3).

d) Part IV of the Act deals with the regulation of public service passenger carrying vehicles and provides for the appointment of Traffic Commissioners who, since 1st April, 1931, are responsible for issuing all licences in connection with public service vehicles. Section 72 (3) (*d*) provides that the Commissioners, in considering the grant of a road service licence, shall have regard to the needs of the area as a whole in relation to traffic (including the provision of adequate, suitable and efficient services, the elimination of unnecessary services and the provision of unremunerative services) and the co-ordination of all forms of passenger traffic, including transport by rail.

The railway companies are entitled to make representations to the Traffic Commissioners with regard to any proposed new road services likely to affect railway interests.

The report for the year ended 31st March, 1934, of the Traffic Commissioners appointed under the above Act has recently been issued. Comments on some of the main statistical features are given below :

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(2) Section 31 of the Road and Rail Traffic Act, 1933, states that time during which the driver is bound by the terms of his employment to obey the directions of his employer, or to remain on or near the vehicle, or during which the vehicle is at a place where no reasonable facilities exist for the driver to rest away from the vehicle, shall be deemed *not* to be time which the driver has for rest.

(3) « A », « B » and « C » Licences. — See Report relating to Road and Rail Traffic Act, 1933, p. 483.

a) **Numbers of operators and vehicles.**

At 31st December.	Number of operators owning :			Total number of vehicles owned by :		
	up to 49 vehicles. (1)	50 or more vehicles. (2)	Total. (3)	(1)	(2)	(3)
1931 . .	6 372	114	6 486	20 760	25 761	46 476
1932 . .	6 193	114	6 307	19 854	26 604	46 458
1933 . .	5 721	113	5 834	18 119	27 016	45 135

It will be seen from the above figures that the number of small operators is steadily decreasing, although the number of large operators has remained practically constant. This is thought to be largely due to the absorption of small operators by the larger companies. The total number of vehicles owned has decreased possibly owing to the co-ordination which the larger companies have been able to introduce in absorption of the smaller undertakings.

b) **Road service receipts and miles** *(In round figures).*

Nature of service.	Receipts.		Vehicle-miles.	
	1933	1932	1933	1932
	£	£	No.	No.
Stage	51 000 000	50 600 000	1 168 800 000	1 175 000 000
Express	2 600 000	3 400 000	65 800 000	76 700 000
Excursions and tours . .	1 800 000	1 700 000	28 700 000	26 600 000
Contract	2 500 000	2 500 000	46 500 000	45 400 000
Total . . .	57 900 000	58 200 000	1 309 800 000	1 323 700 000

Perhaps the most noteworthy fluctuation is that in receipts and miles on express services, which show material decreases. Although there is no direct evidence, this may well in part be due to the introduction by the railway companies of reduced fares.

Road and Rail Traffic Act, 1933.

Part I. — Goods vehicles.

The Act introduces a new principle, for it provides that no person shall use a goods vehicle on a road without a carrier's licence. This licence is quite distinct from, and additional to, a licence for the vehicle (tax). The different classes of licences for goods vehicles are as under :

« A » Licences. — Public carriers (licences valid for two years).

« B » Licences. — Persons who carry goods in connection with any trade or business of their own and also as public carriers (licences valid for one year).

« C » Licences. — Persons who carry goods in connection with their business only (licences valid for three years).

All « A », « B » and « C » licences are granted subject to the following conditions :

(1) That the vehicles are maintained in a fit and serviceable condition.

(2) That the statutory provisions with regard to limits of speed, weight (laden and unladen) and loading of goods are complied with.

(3) That the conditions with regard to drivers' hours and rest periods are observed.

(4) That records of journeys made, goods carried, etc., are kept as provided by the Act.

In addition, « B » licences may have attached to them conditions limiting conveyance for hire or reward to :

a) A defined area or between specified places.

b) Certain classes of goods only.

c) Goods of specified persons.

The Licensing Authority for each traffic area is the Chairman of the Traffic Commissioners appointed under the Road Traffic Act, 1930, for that area.

Broadly speaking, the Licensing Authorities have no power to refuse applications for « C » licences, but have full discretion to grant or refuse applications for « A » or « B » licences, subject to the proviso that for the first licensing period an applicant is entitled to receive a licence for a tonnage (unladen weight) of vehicles equal to that operated at any one time during the year ended 31st March, 1933. In practice, the latter tonnage has become known as « claimed tonnage » and all additional tonnage is termed « discretionary tonnage ».

The licensing system came into operation in the case of « C » vehicles on 1st July, 1934, and in respect of « A » and « B » vehicles on 1st October, 1934.

Under the provisions of the Act, the Licensing Authorities are required, with certain minor exceptions, to publish notices of applications for « A » and « B » licences, and regulations have been made specifying the time within which, and the manner in which, objections may be made.

The Licensing Authorities may hold such enquiries as they think necessary in dealing with applications for and objections to applications for licences, and practically all applications for discretionary tonnage are being dealt with at public enquiries.

The railway companies, as providers of transport facilities, have the right to lodge objection to any application which affects them except in so far as it relates to « claimed tonnage », on the ground that suitable transport facilities in the district or between the places concerned are, or, if the application were granted, would be, in excess of requirements. The railway companies carefully considered their position in the matter, however, and with the feeling that the intention of the Act was to stabilise road transport and to provide a fair basis of competition between road and rail, they made a public announcement of policy which is briefly summarised as follows :

a) Applications for « A » licences made before 1st April 1934, which included both claimed tonnage and discretionary tonnage in possession (the companies were entitled to oppose the latter) would not be opposed. (This, in effect, meant that the application of hauliers who were established before 31st March, 1933, the end of the statutory claimed tonnage

year, would not be opposed except for any additional tonnage they proposed to acquire after 1st April, 1934).

b) Application for « A » licences which did not include claimed tonnage, i.e., the applicant came into the haulage business after 31st March, 1933, would be opposed if the circumstances justified this course.

c) Applications for « B » licences for discretionary tonnage, irrespective or not of whether claimed tonnage was also included, would be dealt with on merit owing to the different considerations which arise on « B » applications, e.g., the restrictive conditions, as to area of operation, etc., which the Licensing Authorities may impose.

The effect of this decision was that numerous applications by road hauliers which were in conflict with railway interests were not opposed.

The Licensing Authorities have been holding public enquiries for some time, but their work in dealing with first applications is not completed, and it is yet too early to give any views on the effect of the operation of the licensing system.

Part II. — Railway agreed charges.

Under Part II of the Act, the railway companies are empowered to enter into arrangements with traders to agree charges for the whole, or a clearly defined portion, of a trader's traffic, which charges are, generally speaking, in the form of a flat rate, irrespective of class of traffic or distance conveyed.

All such agreed charges, before they are legally operative, must be submitted to the Railway Rates Tribunal for approval, including also the conditions attaching to the charge, and it is provided that the object to be secured by such a charge or charges could not, in the opinion of the Railway Rates Tribunal, be adequately met by the granting of appropriate exceptional rates.

Agreed charges, generally speaking, are arranged with a view to :

a) Securing traffic to rail from road.

b) Saving both to the trader and the railway companies in clerical work. In the case of the railway companies a considerable amount of detail in connection with invoicing and accountancy is eliminated.

The charges are usually based on the trader's transport costs (road and/or rail) over a selected period, and may apply either by goods train or passenger train service, or both. In practice, they are generally arranged on a « per package », « per consignment » or « per ton » basis.

There is one exceptional case where an agreed charge is expressed as a percentage of purchase price (i.e., the annual amount expended by the trader in the purchase of goods). The circumstances in this case are unique as the goods brought under the arrangement are received by a trader who deals in a very large variety of commodities sold at hundreds of his branch stores situated in different parts of the country.

Agreed charges are generally arranged for a period of twelve months during which tests are made to see whether there has been any appreciable variation in either the nature of the goods, average weight of the consignments or length of haul. Where this has taken place, an appropriate adjustment is made to reflect these changes before renewal of the agreed charge.

Traders who consider that their interests would be detrimentally affected by the granting of an agreed charge to another trader may appear before the

Tribunal in support of their objections thereto, either when the application is first heard or subsequently.

Any trader who claims that an agreed charge granted to a competitor has detrimentally affected his business can apply to the Tribunal to fix an agreed charge for his traffic on a similar basis, irrespective of whether the same or another railway company is concerned.

The Act safeguards the interests of :

Port or harbour authorities,

Dock companies,

Coastwise shipping interests,

by giving these bodies special rights to object to any agreed charge if they consider they are placed at an undue disadvantage.

The Act further provides that agreed charges are to be taken into consideration in connection with the annual review of all railway charges, provided for under the Railways Act, 1921.

Part III. — General.

Part III of the Act makes provision for the constitution of a « Transport Advisory Council » for the purpose of giving advice and assistance to the Minister of Transport in connection with facilities for transport and their co-ordination, improvement and development.

Road Traffic Act, 1934.

This Act received Royal Assent on the 31st July, 1934, and, in addition to containing new features, amends certain provisions of the Road Traffic Act, 1930.

The outstanding provision of the Act, although it does not affect the railway companies to any great extent, is the imposition of a speed limit of 30 miles per hour in any built-up area. The Road Traffic Act, 1930, prescribed speed limits, in no case exceeding 30 miles per hour, for various types of mechanically-propelled vehicles, but left private motor cars without any speed limit. The effect of the 1934 Act is, therefore, that private motor cars in built-up areas, but not elsewhere, are restricted to 30 miles per hour. In addition, the 1934 Act varies to some extent the speed restrictions imposed upon vehicles, other than private motor cars, by the Act of 1930.

A provision which is of primary importance to railway companies is that relating to what are known as contract carriages, i.e., motor vehicles carrying passengers under a contract for the use of the whole vehicle. Under the Road Traffic Act, 1930 (Section 61), although public service vehicle licences are required, road service licences are not necessary for contract carriages even if separate fares are paid by the passengers, provided, in the latter case, they form a « private party », and the vehicles are used for a « special occasion ». This proviso was found to be capable of varied interpretations, and the terms « special occasion » and « private party » were very widely applied. With a view to correcting this, Section 25 of the 1934 Act defines more precisely what is a « private party », and provides for certain records to be kept by the holder of the licence. These records are not as comprehensive as the railway companies would like, but it is hoped that, together with the definition of a « private party », they will be of assistance by placing this class of road competition on a more regular basis.

Other provisions of the Act strengthen the 1930 Act with regard to penalties for exceeding the speed limits, careless and dangerous driving.

The provisions of the 1930 Act with regard to third party insurances are also amended with a view to making it more

difficult to evade the intentions of those provisions.

In addition, new features included in the Act are tests for all new applicants for licences to drive mechanically-propelled vehicles, and special licences for drivers of heavy goods vehicles.

Finance Act, 1934.

On and from 1st January, 1935, the horse-power tax of private motor cars will be reduced by 25 %, i.e., from £ 1 to 15 sh. 0 d. per horse-power.

Passenger train traffic.

« *Summer tickets* ». — The « Summer ticket » arrangement introduced experimentally from 1st May to 31st December, 1933, has been extended until the end of 1934, and as from 1st January, 1935, the principle of this arrangement will be continued permanently, between any pair of stations in Great Britain, under the title of « Monthly Return Tickets ». These tickets will be available for use on the outward and return journeys any day within one calendar month from date of issue, at the ordinary single fare and one-third for the double journey (fractions of 3 d. reckoned as 3 d.) Third Class; First Class fares fifty per cent (instead of 66 2/3 per cent) over Third Class fares; minimum fares First Class 3 s. 9 d., Third Class 2 s. 6 d., except on the Southern Railway whose minimum fares will be First Class 7 s. 6 d., and Third Class 5 s. 0 d.

Train cruises. — A further four train cruises have been run during the past summer on similar lines to those of the previous year. The cruises have been highly successful and have received their full complement of passengers. The itinerary was slightly modified as compared with that of the previous year.

Electrification. — Developments in electrification have been taking place over a number of years, the most notable being that of the extension by one railway company of its electrified lines to a main line section of its system, making, with the suburban lines previously electrified by that company, a total of 985 track miles.

Further extensions are in progress.

The advantages of the frequent services, coupled with the standardised timings of the electrified trains, have proved a great asset in combating Road competition and developing Rail travel.

Special trips. — With the object of making the travelling public « rail-minded », the British companies have inaugurated educational visits by rail on a large scale to railway locomotive works and other centres of interest. Special trains at cheap fares are also run to cathedral cities and places of historical interest, guides being provided to point out the places of interest en route, and to conduct the passengers over the cathedrals and historical buildings.

Weekly holiday season tickets. — The system of weekly holiday season tickets has been widely extended during the year. These tickets permit unrestricted travel within a prescribed area for a period of one week at a fixed charge.

Conducted rambles. — To cater for the increasing popularity of walking, special trains are run on Sundays from London and other populous centres to the countryside, a notable feature being that experienced guides, familiar with the district to be covered, accompany the pass-

engers during the rambles which, in some cases, are so arranged that the return journey is made from a station different from that at which the outward rail journey terminated.

The fares are on a low basis and include the services of the guides.

These conducted rambles and excursions have attracted a considerable number of passengers, and it is intended to continue them.

Observation excursions. — A number of « observation » excursions to enable passengers to do sightseeing trips by train have been operated with a considerable degree of success.

The trains have been formed of non-compartment carriage stock with large windows, and the excursions have been planned to run slowly through country-side or coast scenery of outstanding interest with a stop of an hour or two's duration at one or two chief points en route.

Camping coaches. — In the summer of 1933 an experimental facility, the camping coach holiday, was introduced, whereby old railway carriages, suitably adapted ans equipped for sleeping, living and cooking purposes, were placed in railway sidings at various places at the seaside and in the country, and were let to the public for weekly periods. One of the conditions attached to the facility was that the tenants must travel to and from the site of the camping coach by rail. A very heavy demand was experienced, which exceeded the supply of coaches available, and an increased number was supplied during the summer of 1934. Further increased facilities of this class will be available in 1935.

Inclusive holiday bookings. — An arrangement was introduced this summer under which passengers could secure hotel or boarding house accommodation through the company, an inclusive price being charged to cover rail journey, hotel or boarding house accommodation and local sightseeing excursions.

The scheme was not introduced until somewhat late in the year, but the bookings indicate that the arrangement is one which is likely to develop into a substantial business.

Buffet cars. — In addition to the dining-car facilities provided on important main line trains, buffet cars, on which light refreshments can be obtained, have been specially built and are used on less important regular trains and excursion trains.

Mutual assistance as between railway companies and associated road companies in cases of emergency.

Arrangements have been made between the railway companies and their associated omnibus undertakings whereby mutual assistance is rendered in cases of emergency.

Under these arrangements, on the breakdown of any vehicle of one of the omnibus companies associated with the railways, the passengers are sent forward by train to their destination at the request of any representative of the omnibus company. No further charge is made to the passenger although third-class single rail tickets are issued. An account is subsequently rendered to the omnibus company for tickets issued.

In the event of a railway breakdown or interruption of service, the omnibus company provides, on intimation from a railway station master or other responsible official, vehicles to convey railway passengers; accounts for the services

performed are rendered to the railway company.

London Passenger Transport Board.

The Act of Parliament authorising the formation of the London Passenger Transport Board became effective as from 1st July, 1933. The object of the measure is « the provision of an adequate and properly co-ordinated system of passenger transport for the London passenger transport area, and for that purpose, while avoiding the provision of unnecessary and wasteful competitive services, to take from time to time such steps as they (the Board) consider necessary for extending and improving the facilities for passenger transport in that area... »

The Act authorised the vesting in the Board of the

a) Underground Railway Group including the London General Omnibus Co.

b) Metropolitan Railway.

c) Tramway and trolley vehicle undertakings of the local authorities and others in the area.

d) Omnibus services operated in the area by independent road transport undertakings.

The Act empowers the Board to provide, inter alia, road services within a defined area radiating approximately 30 miles from the centre of London and also authorises the Board to enter into working arrangements with other operators for services inside and adjacent services outside the area.

Under the Act the services provided by the London Passenger Transport Board will be co-ordinated with the London suburban passenger services of the four main-line companies. To ensure this co-ordination a standing joint committee has been set up consisting of four members appointed by the Board and four by the main-line companies. The duty of this joint committee is to consider the provision or working of passenger services or facilities, through booking arrangements, through working arrangements, and the inter-availability of passenger tickets.

The Act further provides that the whole of the passenger receipts of the new Board shall be pooled with the whole of the passenger receipts from traffic passing between places within the London area of each of the main-line railway companies, and any modification of services or facilities which would affect this pool is to be submitted to and be determined by the joint committee.

Merchandise train traffic.

Livestock rates and insurance. — The railway companies are faced with severe competition from road hauliers for livestock traffic. Many of these hauliers (usually small casual operators) offer extremely low and uneconomic rates. The railway companies, in order to meet this competition to the best of their ability, have :

a) granted exceptional rates for livestock traffic;

b) themselves introduced road motor services for the conveyance of livestock to or from railway stations, and in certain cases for throughout journeys by road; and

c) introduced a scheme of insurance whereby cattle, calves, sheep and pigs may be insured at very advantageous terms against death or injury during transit.

With reference to (*a*) above it has been the recent practice for Rates Repre-

sentatives from the Companies' Headquarters to attend sales throughout the country for the purpose of quoting reduced rates on the spot to secure traffic from the road hauliers.

Railway scheme for the collection on delivery of the value of goods. — For many years past it has been against the regulations of the British railways to accept goods for conveyance with « paid-ons » representing value or part value of the goods. During recent years certain road haulage firms have, however, operated this facility.

On and from 1st July, 1934, an arrangement for the collection on delivery of the value (not exceeding £ 40 in any one case) of consignments handed to the railway companies for conveyance by goods or passenger trains was brought into operation for an experimental period of one year. The scheme applies to goods conveyed between all stations in Great Britain and also certain Continental ports.

Measures taken by the Railways themselves in order to combat road competition.

The circumstances envisaged apply in Great Britain where branch lines have been wholly or partly closed.

Where branch lines have been wholly closed to passenger traffic it is mainly because the traffic has dwindled to such an extent (either through competition from road transport or other causes) that the lines could no longer be economically worked. In certain instances, therefore, where most of the railway passenger traffic has been diverted to road no further provision has been necessary for their conveyance. There are cases, however, where arrangements have been made with an associated omnibus company to divert or augment a road service to provide the necessary means of conveyance to take the place of the railway service withdrawn.

Where branch lines have been partly closed, e.g., on Sundays only, provision has been made for the conveyance of the passengers by road. In such cases arrangements are generally made with the associated omnibus company concerned to run their scheduled service to connect with the principal trains and rail tickets are honoured on the road vehicles. The omnibus company is subsequently credited, in respect of every passenger so carried, with a proportion of the rail fare equal to the road fare for the actual stage or stages travelled; this has been done to conform with the Road Traffic Act, 1930.

Where there is no scheduled omnibus service and road facilities are necessary, arrangements are made with the omnibus company to run a special omnibus and, generally, that company is remunerated on a mileage basis. In most of these instances only passengers holding rail tickets are conveyed on the road vehicle.

When a rail passenger terminates his journey on the road vehicle, the rail ticket is collected by the omnibus company for the purposes of settlement. In the case of a passenger commencing his journey by road a rail ticket is issued in certain instances from the branch line station and as this is subsequently collected at the destination station, the omnibus conductor would keep a record of the journey (with full particulars of the rail ticket, i.e., date, number, class, etc.) for the purposes of settlement. In other cases passengers book by road service to the junction station and re-book by rail from that point to destination.

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AIRWAYS.

In pursuance of the powers conferred on them by Acts of Parliament, the four British Railway Companies, in association with Imperial Airways, Ltd., formed a company in March, 1934, for the purpose of operating air services within the British Isles. The company, known as Railway Air Services, Ltd., commenced the actual operation of air services on May 7th, 1934, with the opening of the route from Plymouth to Liverpool, calling at Teignmouth, Cardiff and Birmingham.

On July 30th, 1934, the route from Birmingham to Cowes, Isle of Wight, calling at Bristol and Southampton, was commenced, and on August 20th a further route from London to Birmingham, Manchester, Belfast and Glasgow was opened. Connections were given at Birmingham between the various services.

On August 20th the carriage by air of mails for the Post Office commenced.

Arrangements were also entered into with an independent air company — Spartan Air Lines — for the working of an air service between London and the Isle of Wight. This service commenced on May 1st, and arrangements were made whereby passengers travelling by air on the outward journey could return by rail, or vice versa.

Certain of the air services have been discontinued during the winter months.

[656. 222.1]

Note on Train Speeds,

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PART II *(Continued).* (1)

Train speeds and services in different countries.

VIII. — AUSTRIA.

SUMMARY.

NOTE.

Train timings are taken from the Austrian 1934 summer time tables.

CHAPTER XXXII.

The railway system.

XXXII-1. — **General.** — Although the political and social effects of the Great War on Austria and Hungary were incalculable, its influence on railway services was much less, as the former Empire was already subdivided to a certain extent. Consequently, there have been relatively few changes in the major services between Austria and foreign countries.

Such is not the case when territory is transferred to another flag, as it has to be brought within the new capital's influence. Furthermore, when new frontiers are being settled, railway policy is usually swayed by other than railway considerations and many lines have found themselves in such a position that it has

(1) Cf. *Bulletin of the International Railway Congress Association*, October and November 1933 (pp. 885 and 1027); January, May, June and July 1934 (pp. 63, 407, 561 and 653); February, March and April 1935 (pp. 141, 275 and 375).

become indispensable to alter them if they were to survive.

Mountain lines. — Austria is primarily a mountain country : 457 km. (284 miles) of its railways have gradients of 1 in 59 to 1 in 40, and 180 km. (112 miles) are steeper still, in spite of the driving of 88 km. (55 miles) of tunneling. This has greatly influenced train speeds and services and it is therefore necessary to recapitulate the chief characteristics of the main lines. We have grouped them under the following headings :

Transalpine international lines;
Transalpine internal lines;
Other mountain lines.

International transalpine lines. — The Innsbruck-Vienna railway follows the northern slopes of the Austrian Alps which, under various names (1), stretch from the western frontier to the capital.

Along the southern slopes runs the Fortezza (Franzensfeste)-Klagenfurt railway.

From East to West, the Arlberg Railway crosses them, whereas three trunk lines : the Semmering, the Tauern and the Brenner railways, besides a few of local interest only, run through them longitudinally.

a) The SEMMERING LINE, constructed by the former *Südbahn*, connects Vienna with Trieste and Venice. Inaugurated in 1854, this was the first Alpine railway to cross the range and that at an altitude of 900 m. (2 963 feet) only above sea level (the Adriatic being taken as a basis). Gradients reached 1 in 40 (2) and it was not known, whilst building it, how trains were to negotiate them (3). In view of these difficulties, rates based on virtual distances were to be applied, this being, as far as we have ascertained, the first instance where it was done.

The following data are of interest :

	Distance.				Altitude.	
	For tariff purposes.		*Actual.*			
	Km.	Miles.	Km.	Miles.	Metres.	Feet.
Gloggnitz	75	46.6	75	46.6	437	1 434
Semmering	128	79.5	109	67.7	894	2 933
1 431-m. (0.89-mile) tunnel.					896	2 940
Steinhaus	137	85.1	108	67.1	837	2 746
Mürzzuschlag	155	96.3	117	72.7	679	2 228
Bruck a. d. Mur	196	121.8	158	98.2	496	1 627

(1) On either side of the Brenner : the Ötztaler Alpen in the West (the Wildspitze is 3 774 m. = 12 382 feet high), and the Zillerthaler Alpen in the East.
The Tauern, on either side of the tunnel : In the West, the Hohe Tauern (the Grossglockner, 3 798 m. = 12 460 feet); the Sonnblick 3 103 m. = 10 180 feet) and the Niedere Tauern as far as the Eisenerz railway.
(2) Maximum gradients are 1 in 40 on the northern and 1 in 45 on the southern slope.
(3) For further information, see « ARTICULATED LOCOMOTIVES » (Constable and Co., London), by the same author.
The Semmering 1851 contest ruled that the locomotives should be able to haul 140 t. (138 Eng. tons) up 1 in 45 gradients at a speed of 11.5 km. (7.2 miles) per hour, while the boiler pressure was limited to 8.5 kgr./cm² (120.8 lb. per sq. inch) and the axle load, to 14 t. (13.8 Eng. tons).
Articulated locomotives as a practical proposition were used here for the first time and the Maffei, Wiener-Neustadt and Seraing systems, besides the Engerth semi-articulated locomotives, appeared here and came to stay — at least for quite a time.

b) The KARAWANKEN LINE, from Trieste to Salzburg, was a considerable undertaking which lay entirely within the boundaries of the former Austro-Hungarian Empire. It comprised 17 km. (11.6 miles) of tunnels, three of which were long ones.

The first of them, the Karawanken tunnel, 8 960 m. (5.57 miles) long, between Assling (Jesenice) and Rosenbach, crosses the frontier, only 4 350 m. (2.7 miles) of it now remaining in present-day Austria.

The second one crosses the Tauern range. It is 8 550 m. (5.31 miles) long, between Mallnitz and Böckstein, just before the Badgastein spa. Gradients reach 1 in 33 on both slopes.

Although this railway is generally single-track only, two tracks exist in the two long tunnels. It has been electrified from the southern portal of the Tauern tunnel as far as Scharzach-St. Veit, where it joins with the Salzburg line, and the southern section is to be electrified very shortly. Interesting data are as under :

	Distance.				Altitude.	
	For tariff purposes.		*Actual.*			
	Km.	Miles.	Km.	Miles.	Metres.	Feet.
Assling	0	0	0	0	573	1 880
The Karawanken tunnel					613-626	2 011-2 054
Rosenbach	17	10.6	13	8.1	602	1 975
Villach	44	27.3	27	16.8	602	1 975
Spittal	80	49.7	73	45.4	544	1 785
Mallnitz	127	78.9	108	67.1	1 180	3 871
The Tauern tunnel . .					1 218-1 173	3 996-3 848
Böckstein	140	87.0	119	73.9	1 171	3 842
Badgastein	145	90.1	124	77.1	1 083	3 553
Schwarzach—St. Veit. .	185	115.0	154	95.7	591	1 939
Bischofshofen	199	123.7	168	104.4	544	1 785
Salzburg	252	156.6	221	137.3	424	1 391

The existence of a relatively large number of railways in the Villach-Klagenfurt district is due to the fact that it was served by the *Südbahn*'s Graz-Marburg-Klagenfurt-Villach-Spittal - Franzensfeste line (fig. 182) and by the *State Rys.*'s, the latter administration exercising running powers between Villach and Spittal, over the Company's line. On the other hand, the Karawanken line, via Klagenfurt and Leoben was *State*-owned, whereas the extension to Vienna was the *Südbahn*'s property.

From St. Veit, the line is double tracked save along the last 12 km. (7.5 miles) between St. Michael and Leoben.

c) The BRENNER RAILWAY, an important trunk line between Bavaria and Italy, is the second oldest of the great lines across the Alps [1], and the only one to cross the Brenner pass (on the frontier) in the open. The figures are as follows :

(1) Open to traffic on the 24th August 1867, the Brenner line brought both Munich and Vienna within 18 hours of Milan. Today, is takes half the time to cover the distance.

	Distance.				Altitude.	
	For tariff purposes.		Actual.			
	Km.	Miles.	Km.	Miles.	Metres.	Feet.
Innsbruck	0	0	0	0	578	1 896
Matrei	43	26.7	17	10.6	588	1 929
Stainach	50	31.1	22	13.7	1 050	3 445
Brennersee	81	50.3	37	23.0		
The Brenner pass	82	50.6	38	23.6	1 368	4 488
Giggelberg	90	55.9	44	27.3	1 239	4 065
Gossensass	99	61.5	54	33.6	1 060	3 478
Brixen	134	83.3	87	54.1	571	1 873

Gradients reach 1 in 44 on the southern slope, and 1 in 40 on the northern. Electric operation exists along the whole line.

The Brenner line has two extensions which only differ in length by some 15 km. (9.3 miles) and connect Innsbruck with Munich. The distance is 158 km. (98.2 miles) via Garmisch and 172 km. (106.9 miles) via Kufstein (1). While the layout of this latter line is a relatively easy one, the Garmisch line crosses a secondary mountain range at a high altitude :

	Distance.				Altitude.	
	For tariff purposes.		Actual.			
	Km.	Miles.	Km.	Miles.	Metres.	Feet.
Innsbruck	0	0	0	0	582	1 896
Highest point					1 184	3 884
Seefeld	33	20.5	24	14.9	1 181	3 875
Mittenwald	54	33.6	40	24.9	913	2 995
Garmisch	76	47.2	57	35.4	745	2 444
Munich	177	110.0	158	98.2	520	1 706

d) The ARLBERG RAILWAY is the main Austrian line of the present day, as it crosses the country along its greatest length and links up Vienna with Zurich, Basle and beyond. The most difficult section, 136 km. (84.5 miles) long, from Innsbruck to Bludenz, includes a 10 240 m. (6.34 miles) tunnel (2), which, at a height of 1 300 m. (4 265 feet) above sea level, connects the Danube (and its tributary the Inn) with the Rhine Basin (and the Ill). Maximum gradients are 1 in 38 on both slopes :

(1) The distance from Munich to Kufstein is 99 km. (61.5 miles), to Wörgl 112 km. (69.6 miles), and to Innsbruck 172 km. (106.9 miles).

(2) Begun in November 1880, the tunnel was completely driven by November 1883 and work finished in May 1884.

	Distance.				Altitude.	
	For tariff purposes.		*Actual.*			
	Km.	Miles.	Km.	Miles.	Metres.	Feet.
Innsbruck	0	0	0	0	576	1 890
Landeck	73	45.4	72	44.7	777	2 549
St. Anton	109	67.7	100	62.1	1 302	4 272
The Arlberg tunnel, maximum.					1 310	4 298
Langen	124	77.1	111	69.0	1 217	3 993
Bludenz	161	100.0	137	85.1	558	1 831

At the time the line was built, the stations were spaced, for military reasons, at an average distance of 6 1/2 or 13 km. (4 or 8 miles) apart, according to the section.

The Arlberg range, which separates the Lech and Inn watersheds, is also crossed further north, where conditions are much easier, by the Garmisch-Kempten regional railway (1), whose extremities lie in Bavaria and whose central portion alone is in the Tyrol. Between Garmisch and Ehrwald, this railway runs round the base of the Zugspitze (2).

Apart from these international lines, a few others also cross the mountains, while several only run up one of their slopes.

e) The VORDERNBERGBAHN is 64 km. (39.8 miles) long, from Leoben to Hieflau, whence it has been extended both West and North. It is unique in Austria in being the only important railway with a rack section 19 765 m. (12.3 miles) long, with a maximum gradient of 1 in 14. This has enabled it to serve the following places :

	Actual distance		Altitude	
	Km.	Miles.	Metres	Feet.
Leoben	0	0	566	1 857
Vordernberg	20	12.4	768	2 520
Erzberg	38	23.6	1 070	3 510
Eisenerz	49	30.5	692	2 270
Hieflau	64	39.7	489	1 604

(1) The following are the distances and altitudes :

	Distance.				Altitude.	
	For tariff purposes.		*Actual.*			
	Km.	Miles.	Km.	Miles.	Metres.	Feet.
Garmisch	0	0	0	0	745	2 444
Ehrwald (Austria)	26	16.2	22	13.7	974	3 195
Bichlbach	41	25.5	32	19.9	1 073	3 520
Reutte	57	35.4	46	28.6	849	2 785
Pfronten (front.)	75	46.6	64	39.8	858	2 815
Kempten (Bavaria)	106	65.9			695	2 280

(2) The summit of the Zugspitze is 2 964 m. (9 757 feet) above sea level. The Austrian cable railway 3 280 m. (2.04 miles) long, runs from Ehrwald-Obermoos (altitude 1 224 m. = 4 015 feet) to Zugspitzkamm (altitude 2 805 m. = 9 193 feet).

The Bavarian line is 17.4 km. (10.8 miles) long as far as Gramain, whence a rack section of 2 610 m. (1.62 miles) (maximum gradient 1 in 83) runs up to Schneefernerhaus. A telpher line 610 m. (0.38 mile) long, runs right up to the summit (2 958 m. = 9 705 feet above sea level).

The latest locomotives are still the first and, up to the present, the only twelve-coupled rack locomotives in existence (1) (fig. 177).

f) Immediately to the West of the preceding line, there is a transalpine simple-adhesion railway, running from St. Michael (12 km. = 7.5 miles from Leoben)

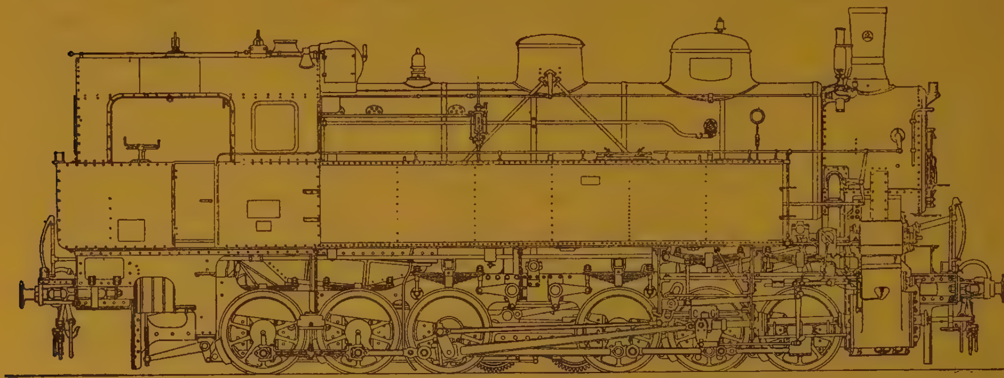


Fig. 177. — Combined adhesion and rack 0-12-0 T locomotive, built in the Floridsdorf Works.

to Selzthal (63 km. = 39.2 miles), whence it has been extended to Linz. From its highest point, at an altitude of 843 m. (2 766 feet) only, it runs, immediately north of Selzthal, through the Bosruck tunnel (4 766 m. = 2.97 miles) and descends continuously to an altitude of 415 m. (1 361 feet). The line from Stainach-Irdning to Attnang-Puchheim, which somewhat duplicates it to the West, is a very similar one :

	Distance.				Altitude.	
	For tariff purposes.		*Actual.*			
	Km.	Miles.	Km.	Miles.	Metres.	Feet.
St. Michael	0	0	0	0	594	1 949
Wald	31	19.3	30	18.6	843	2 766
The Bosruck tunnel . .					719-696	2 359-2 283
Selzthal	64	39.8	63	39.1	635	2 083
Kirchdorf	124	77.1	147	91.3	449	1 473
Linz	175	108.7	167	103.8		

(1) The old 2-6-0-T locomotives, 18 of which are still in use, weighed 62 t. (61 Engl. tons) in running order (48.8 t. = 48 Engl. tons empty) with an adhesive weight of 47 t. (46.3 Engl. tons). They hauled 80-t. (78.7 Engl. tons) passenger- or 110-t. (108 Engl. tons) goods trains at a speed of 20 km. (12.4 miles) an hour over the rack section and 30 km. (18.6 miles) an hour over the simple-adhesion sections.

The 0-12-0-T locomotives, built in 1913 by the *Floridsdorf Works,* ran at the same speeds. They weigh 88 t. (86.6 Engl. tons) in working order, i.e. 14 t. (13.8 Engl. tons) per axle, and haul respectively 120 and 180 t. (118.1 and 177.2 Engl. tons) up gradients of 1 in 14, i.e. 1 1/3 and 2 times their own weight.

	Actual distance.		Altitude.	
	Km.	Miles.	Metres.	Feet.
Stainach-Irdning	0	0	642	2106
Klachau . . .	10	6.2	833	2733
Bad Aussee . .	30	18.6	638	2093
Bad Ischl . .	63	39.1	466	1529
Gmunden . .	95	59.0	479	1572
Attnang - Puchheim . . .	108	67.1	415	1362

Other mountain lines on one slope only. — The metre-gauge, now electrified, St. Pölten-Mariazell and Gusswerk railway falls within this category.

Its 91 km. (56.5 miles) include, between Laubenbachmühle and Mariazell, a 43-km. (26.7 miles) mountain section, which includes the Gösing 2 368-m. (1.47 mile) tunnel, access to which is gained by means of a double loop, 17 km. (10.6 miles) long on a 1 in 43 gradient, rising from 530 to 871 m. (1 739 to 2 857 feet), the distance between extreme points being only 5 km. (3.1 miles) as the crow flies (1). This is an application to a metre-gauge line of the classical Gossensass (Brenner line) loop (fig. 178).

Fig. 178. — The Gossensass loop (Brenner line).

The Murtelbahn, 77 km. (47.8 miles) long, from Unzmarkt (altitude 733 m. = 2 405 feet) to Mauterndorf (altitude 1 116 m. = 3 661 feet) is an extension towards Badgastein in the Upper Mur valley, of the *Südbahn*'s main line.

The Zell am See (altitude 752 m. = 2 467 feet) to Krimml (altitude 912 m. = 2 992 feet) Railway is similar to the above. It is 54 km. (33.6 miles) long.

(1) The characteristics of this line are as follows :

	Distance.				Altitude.	
	For tariff purposes.		*Actual.*			
	Km.	Miles.	Km.	Miles.	Metres.	Feet.
St. Pölten	0	0	0	0	269	883
Laubenbachmühle . .	52	32.3	48	29.8	534	1 752
The Gösing tunnel . .					892-890	2 926-2 920
Gösing	78	48.5	67	41.6	890	2 920
Mariazell	101	62.8	84	52.2	849	2 785
Gusswerk	110	68.4	91	56.5	739	2 425

The Orscher, facing Gösing, is 1 892 m. (6 207 feet) high. The line crosses the Erlauf torrent at a height of 360 m. (1 181 feet) above it; gradients nowhere exceed 1 in 40.

XXXII-2. — **Structure of the Austrian railway system.** — Though this is essentially a radiating system, some of the lines are so very long that, at some distance from Vienna, they run more or less parallel to one another. On the other hand, a lengthy stretch of country (the Tyrol) extends as a distended wedge between neighbouring countries and, before the war, Bohemia was in a similar position. Lines more or less perpendicular to the radiating ones, such as North and South lines across the Tyrol, cross these areas and ensure through connections between the countries beyond the frontiers, in this case, between Bavaria and Italy. They divide the system into a series of parallelograms, which explains how a number of alternative services, practically of equal length, came into being, following either base of the parallelograms or even a median line across them. Thus, Vienna-Innsbruck services occurred along the three following routes :

a) Bruck-Klagenfurt-Franzensfeste;
b) Amstetten-Selzthal-Bischofshofen;
c) Amstetten-Salzburg-Bischofshofen.

Likewise, there are *alternative international lines* between Vienna and the neighbouring capitals, particularly Prague, Berlin and Budapest. Expresses also ran from Vienna to Trieste or Verona both by the *Südbahn* and the *State Rys.* lines but, owing to the new division of Europe, these services have now been altered.

Conjugated towns. — We have previously quoted several instances of them, such as Liverpool and Manchester, Glasgow and Edinburgh, Brussels and Antwerp, Amsterdam and The Hague.

The case of Vienna and Budapest is still more typical, because the consequences of this situation have been fully developed, and the conditions which determined the construction of the railways were not complicated by other outside factors. It is therefore of some interest to deal with the problem more completely than we have previously done, as it leads to some interesting conclusions.

The lines radiating from Vienna are all to the West of the Oderberg (Bohumin)-Vienna-Klagenfurt transverse line, whilst those radiating from Budapest, lie parallel to the East of the Lemberg (Lwow)-Budapest-Nagykanisza transverse

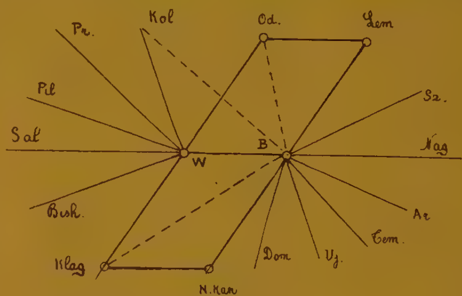


Fig. 179.

line (fig. 179). The northern and southern base lines of the Oderberg-Lemberg and Klagenfurt-Nagykanisza parallelogram are more or less parallel with the two median Vienna and Budapest lines, which are situated on either bank of the Danube.

The Vienna-Oderberg radius being inclined less than 90° on the median, a direct line from Budapest to Oderberg was built so as to avoid following the two sides of an acute angle. A symmetrical case in the South had similar effects and led tot the construction of the Vienna-Nagykanisza parallel line. Moreover, these two lines are the only radii within the parallelogram which could have been obtained by simply shifting the Oderberg-Vienna-Klagenfurt transverse line so as to coincide (more or less) with the Lem-

berg - Budapest - Nagykanisza transverse line.

The problem arising here (and in many similar cases — which is why it is interesting) is to decide when it becomes opportune to build such interior radiating lines in order to travel more easily from one of the « conjugated towns » to an outside one without going through the second.

No time is saved when the Vienna radius forms an angle of 180° with the Budapest-Vienna line, but as the angle decreases, the saving in time increases. When the angle is very wide, the saving is negligible owing to the cost of building a new line, but it increases rapidly as the angle approaches 90°, and becomes of definite value beyond this degree.

To make the point quite clear, here are a few examples. If the distance from Budapest be equal to that travelled on each of the Viennese radiating lines, the time saved, all other factors being equal, would be :

0 % for an angle of 180° (as is the case with Salzburg);
7 % for an angle of 135° (as is the case with Pilzen);
17 % for an angle of 120° (as is the case with Prague);
30 % for an angle of 90° (as is the case with Brünn).

Now the distance travelled over the Viennese radiating lines varies according to the destination. Let us therefore consider figure 180, on which we have mark-

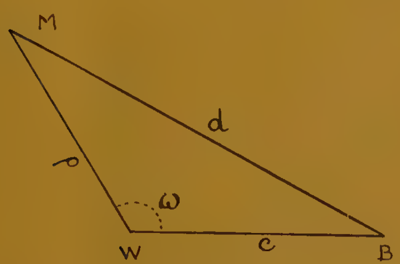


Fig. 180.

ed the « conjugated towns » and let d be the length of the direct line between one of them, B, and another place, M, so that the distance BM is r % shorter than the distance BWM. It is easy to fix the position of M on the line WM by solving two equations, one representing the relations between the three sides of the triangle, with W for its peak and an angle at the peak (which is a known parameter for each given case), and the other stating that d is r % shorter than $\rho + c$:

$$d = \frac{100 - x}{100} (\rho + c).$$

The locus of the peak M according to the values of r is shown in figure 181.

Actually, the Oderberg-Vienna-Klagenfurt transverse line and its parallel are not perpendicular to the Budapest-Vienna median, but the problem does not depend upon the slope on the polar axis.

Let c be the constant distance BW;

let r the value of the decrease in % of the length of d in comparison to $(\rho + c)$

$$d = (\rho + c)\left(1 - \frac{r}{100}\right)$$

Let m be the value of the second parenthesis $\left(1 - \frac{r}{100}\right)$.

In practice, d must be $< (c - d)$ and $m < 1$.

$$d = (\rho + c)\, m$$
$$d = \rho^1 + c^2 - 2\, \rho\, c \cos \omega.$$

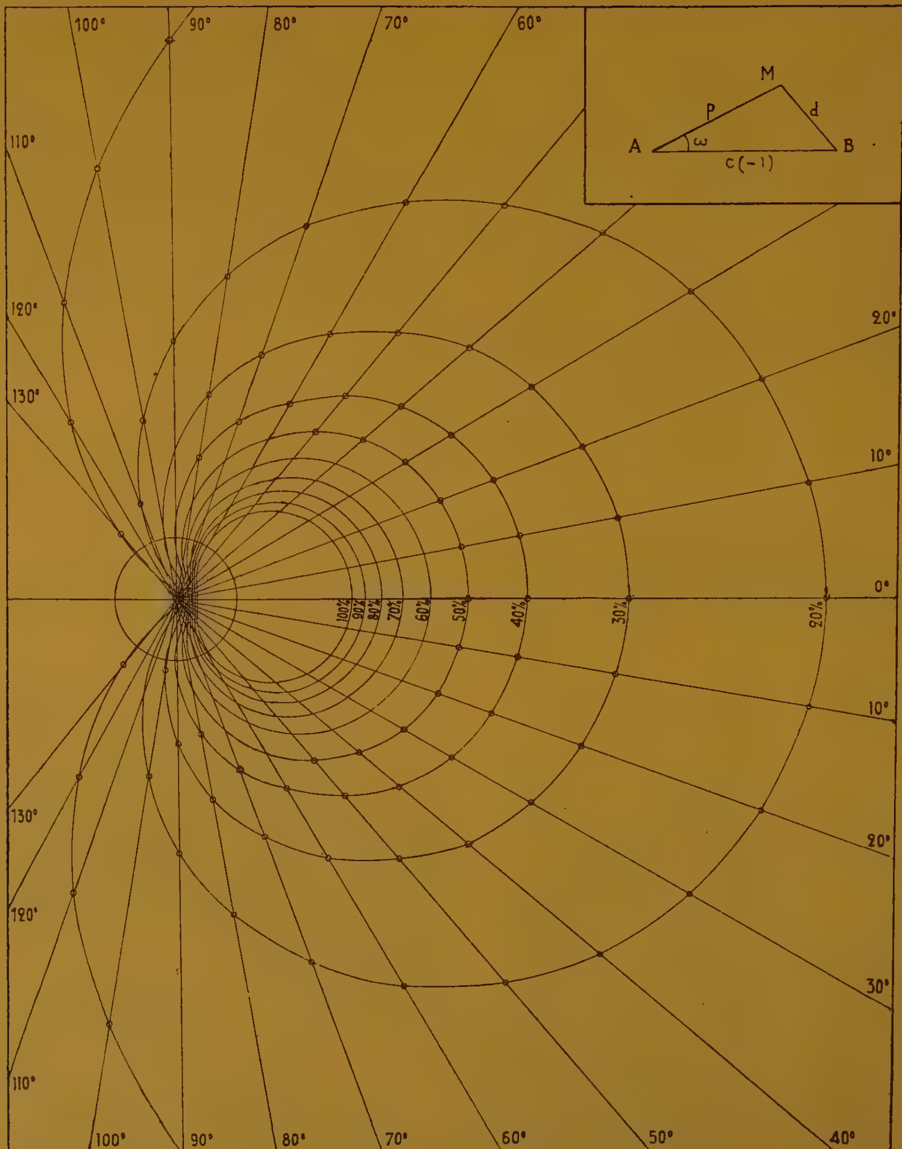


Fig. 181. — Geometric locus.

The polar equation is :

$$(\rho + c)^2\, m^2 = \rho^2 + c^2 - 2\, \rho\, c \cos \omega.$$

Developed :

$$(\rho^2 + 2\, \rho\, c + c^2)\, m^2 = \rho^2 + c^2 - 2\, \rho\, c \cos \omega$$

and the value of ρ :

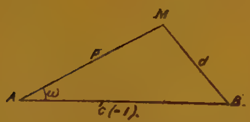
$$\rho = \left\{ \frac{\cos\omega + m^2}{1 - m^2} \pm \sqrt{\left(\frac{\cos\omega + m^2}{1 - m^2}\right) - 1} \right\}$$

For ρ to be real

$\dfrac{\cos\omega + m^2}{1 - m}$ must be > 1 and

$\cos\omega > 1 - 2\,m^2$.

TABLE 179.



$c = 1 \quad \rho = \dfrac{a^2 \cos\omega + 1}{a^2 - 1} \pm \sqrt{\left(\dfrac{a^2\cos\omega + 1}{a^2 - 1}\right) - 1} \quad \cos\omega_0 = 1 - \dfrac{r}{a^2}$

$a = 1 + \dfrac{r}{100} \qquad r = \text{rate in } \%_0 \qquad d = \dfrac{\rho + c}{a}.$

	log. a^2	0.0828	0.1584	0.2279	0.2933	0.3522	0.4082	0.4609	0.5105	0.5575	0.6021
	a	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
log. cos ω	ω r%	10	20	30	40	50	60	70	80	90	100
	0°	20.99 0.05	11.03 0.08	— —	6.01 0.17	5.01 0.21	4.33 0.23	3.86 0.26	3 50 0.28	3.23 0.31	2.99 0.33
9.9934	10	20.85 0.05	10.90 0.08	7.59 0.13	5.93 0.17	4.94 0.20	4.29 0.23	3.81 0.27	3.45 0.29	3.18 0.32	2.96 0.34
9.9730	20°	20.31 0.05	10.61 0.09	7.36 0.14	5.75 0.18	4.77 0.21	4.12 0.24	3.65 0.27	3.31 0.31	3.03 0.33	2.82 0.36
9.9375	30°	19.45 0.05	10.11 0.09	6.99 0.15	5.43 0.19	4.50 0.22	3.86 0.26	3.41 0.29	3.07 0.33	2.80 0.36	2.59 0.39
9.8843	40°	18.28 0.05	9.45 0.09	6.50 0.16	5.01 0.21	4.12 0.24	3.51 0.29	3.08 0.32	2.75 0.37	2.48 0.40	2.27 0.43
9.8081	50°	16.36 0.05	8.64 0.12	5.83 0.18	4.48 0.22	3.64 0.28	3.06 0.32	2.64 0.38	2.33 0.43	2.06 0.48	1.84 0.54
9.6990	60°	15.21 0.07	7.69 0.13	5.15 0.19	3.76 0.26	3.07 0.33	2.53 0.39	2.10 0.48	1.78 0.56	1. 0.68	
9.5341	70°	13.38 0.08	6.64 0.16	4.35 0.23	3.17 0.31	2.42 0.42	1.87 0.53	1.39 0.73			
9 2397	80°	11.42 0.08	5.50 0.18	3.47 0.29	2.37 0.43	1.60 0.62					
	90°	9.41 0.11	4.31 0.23	2.50 0.40	1.33 0.75						
n 9.2397	100°	7.38 0.14	3.09 0.33	1.33 0.80							
n 9.5341	110°	5.40 0.18	1.71 0.39								
n 9.6990	120°	3:47 0.29									
n 9.8081	130°	1.40 0.72									
limit ω_0	—	131°	113°	101°	91°	84°	78°	72°	67°	64°	60°
-log.(a^2-1)	—	0.6778	0.3565	0.1612	0.0177	1.9031	1.8069	1.7235	1.6798	1.5834	1.5229

It is easy to deduce the values of ω giving the angle at and after which the solution becomes possible, limit for which $\rho = c$.

The polar axis is a symmetrical axis of the curve somewhat similar to Pascal's spiral, perpendicular to the polar axis and tangent to the limiting vector. If m increases (i.e. if r decreases) ω increases and vice versa.

In order that $= 0$ for the polar axis, there are two values of ρ :

$$\rho' = \left(\frac{1+m}{1-m}\right) c \text{ and } \rho'' = \left(\frac{1-m}{1+m}\right) c.$$

The variation of the curve is easily followed :

If r decreases, ω increases, ρ' increases and ρ'' decreases. The curve lies outside the one we have considered.

Contrariwise, if r increases, ω decreases, ρ' decreases, ρ'' increases, and the curve is inside in relation to the other.

We have drawn the curve (fig. 181) for all the percentages from 10 to 90° and shown the values corresponding to table 179. There is no difficulty in drawing it and the economic conclusions can easily be deduced from it [1].

XXXII-3. — **Constitution of the present-day system.** — Since the expropriation of the Austrian *Südbahn*'s lines (fig. 182), the *State* has operated 5 345 km. (3 321 miles) of standard, and 507 km. (315 miles) of narrow-gauge track. The only Companies of any importance still in existence and operating their own lines are the following :

TABLE 180.
AUSTRIAN RAILWAY COMPANIES.

COMPANY.	Gauge.	Km.	Mileage.	Line.	(*)
Wien-Aspangbahn	4 ft. 8 1/2 in.	87	54.1	Vienna to Aspang.	
Schneeberg Bahn	Do.	71	44.1	Sollenau-Puchberg.	
Raab-Ödenburg-Ebenfurth	Do.	50	31.0	Neusiedl-Esterhaza.	
		28	17.4	Ebenfurth-Ödenburg.	
Steiermärkische Landeseisenbahn . .	Metre.	64	39.8	Gleisdorf-Weiz-Ratten.	
Köflacherbahn	...	137	85.1	Graz-Köflach- and Wies.	
Murtelbahn (Steiermark)	...	77	47.8	Unzmarkt-Mauterndorf.	
El. Lokalbahnen, Linz	...	69	42.9	Linz, Neumarkt, etc.	E.
Stern und Huffel	...	66	41.0	Lambach-Haag-Gmunden	S.
Salzkammergut Lokalbahn	...	68	42.3	Salzburg-Bad Ischl.	E.
Salzburger Eisenbahn	...	26	16.2	Salzburg-Lamprechtshausen.	
Zillerthalbahn	...	32	19.9	Jenbach-Mayrlofen.	
Achenseebahn	...	7	4.35	Jenbach-Achensee.	M
Stubaitalbahn	...	25	15.5	Innsbruck-Fulpmes.	E.
Innsbrucker Lokalbahn	...	12	7.5	Innsbruck-Hall i./Tirol.	

(*) *Abbreviations : E* = Electric traction. — *S* = Steam traction. — *M* = Mixed adhesion and rack railway.

XXXII-4. — **Track- and loading gauges.** — The *Verein* loading gauge is standard in Austria.

Certain railways have been built to the metre gauge, and others to the 0.76-m. (2 ft. 5 7/8 in.) one. The old Austro-Hun-

(1) Part of the above information is taken from an earlier article we published in *The Railway Gazette* in 1916.

garian Empire was, in fact, the first to have appreciated the possibilities of this latter gauge, which it adopted for its Bosnian strategic railways. But this country having been severed from it, will be dealt with in the chapter relating to Jugoslavia.

XXXII-5. — **Tariff kilometrage.** — Clause 3 of the law of the 15th July 1877 (completed on the 25th May 1890), stated that sections with gradients steeper than 1 in 67 should be increased, for tariff purposes, by 150 or 50 % of their own length.

Thus, tariff kilometrage of a couple of sections of the former *Südbahn*'s Vienna-Bludenz main line, worked out as follows :

VIENNA S.—MÜRZZUSCHLAG.

Actual distance		*116 727 m.*
Length	Less than 1 in 67	91 671 m.
	More than 1 in 67	25 056 m.
	150 % additional length.	37 584 m.
Distance, for tariff purposes		154 311 m.

INNSBRUCK HB.—BLUDENZ.

Actual distance		*136 281 m.*
Length	Less than 1 in 67	88 802 m.
	More than 1 in 67	47 479 m.
	50 % additional length	23 739 m.
Distance for tariff purposes		160 020 m.

TABLE 181.

A FEW INSTANCES OF TARIFF- AND ACTUAL DISTANCES.

Line.	SECTION.	Distance.		Additional.	
		Actual.	Tariff.	Km.	%
Semmering	(Vienna S.) Payerbach-Semmering	20	46	26	130
	Semmering-Mürzzuschlag	14	27	13	93
Arlberg	(Innsbruck) Landeck-St. Anton	28	36	8	29
	St. Anton-Bludenz	37	52	15	41
Brenner	Innsbruck-Brennersee	37	81	44	118
Tauern	Schwarzach-Badgastein	30	40	10	30.3
	Badgastein-Spittal	50	65	15	30
	Regional lines.				
Nieder Österr. Steierische Alpenbahn	St. Pölten-Mariazell-Gusswerk	91	110	19	21
Mittenwaldbahn	Innsbruck-Mittenwald-Garmisch	57	65	8	14

Any fraction of a kilometre, no matter how small, is counted as a complete kilometre in order to keep to round numbers.

CHAPTER XXXIII.

The trains.

XXXIII-1. — **General : Classes of train.** — Austria is rapidly developing both its rail motor coach ordinary and express services. Other services comprise locals, expresses and « D » trains, often very heavy ones, consisting as they do, of through bogie coaches to a number of places.

The *Sleeping-Car Co.* 's trains are the most important of them and, up to now, the *Mitropa* has not run any complete

Fig. 182. — The former Austro-Hungarian *Südbahn* system.

Note: Autres ch. de fer = other railways. — Sections de péage = running powers.

Fig. 183. — Trans-Viennese lines and « de luxe » services.

Note: Trains trans-viennois = Trans-Viennese trains. — Supprimé = obsolete. — Bundesbahnen = Federal Railways. — Stadtbahn = Metropolitan Railway.

trains into the country, though it maintains a number of isolated Austro-German services.

Numerous Viennese suburban trains consist of small light stock but this traffic has lost much of its importance, and these steam-hauled trains still run at the same speed as before the war. Here are a few instances of suburban and local train speeds :

TABLE 182.

A FEW SUBURBAN TRAIN SERVICES.

RUN.	Distance.		Time of departure.	Time spent.	Number of stops.	Speed	
	Km.	Miles.				Km./h.	Miles/h.
Stadtbahn.							
Hütteldorf-Heiligenstadt	...	...	5.01 a. m.	0.36	16	...	...
Hiltzing - Friedenbrücke - Meidling	...	...	5.18 a. m.	0.44	19	...	...
Heiligenstadt Süd and Ost Bhf.	...	...	5.06 a. m.	0.34	7	...	...
Circle (Fed. Rys.).							
Hütteldorf-Vienna N.	17	10.6	5.29 a. m.	0.40	11	25.5	15.8
Do. -Heiligenstadt	36	22.4	6.25 p. m.	1.22	17	26	16.2
Viennese suburbs.							
Vienna W.-Neulenglach . . .	39	24.2	1.08 p. m.	1.05	16	36	22.4
Vienna S.-Leobersdorf . . .	34	21.1	10.45 a. m.	1.01	11	37.2	23.1
Vienna S.-Baden	27	16.8	Do.	0.43	9	33.0	20.5
Vienna Oper.-Baden J. Pl. . .	30	18.6	7.00 a. m.	1.09	14	26.1	16.2

XXXIII-2. — **Trans-Viennese services** (fig. 183). — Such important through trains as the « Orient Express » ran for many years into two Viennese termini, not only with the object of serving two distinct parts of the city, but also so as to lose enough time to arrive elsewhere at convenient timings. Now that long-distance journeys have to be protected from air and road competition, considerations of the kind have lost much of their weight and the interests of the undertaking as a whole are paramount.

Consequently the time spent stopping at the termini has been cut down; one of the termini has usually been done away with.

Since the north-western portion of the Circle line is no longer used for transit traffic, the trains make a considerable detour by southern and eastern parts of the outer Circle line in order to get from the West to the Nord station. The Inner Circle, which is not so elaborate, uses certain sections of the radiating main lines.

The *Stadtbahn* is operated, in conjunction with the electric trams and the *Verbindungsbahn*, with the main lines. There are, besides, a few electrified local lines.

As the distances of the various routes are somewhat difficult to obtain, we quote them hereafter in table 183.

TABLE 183.

RUNS BETWEEN VIENNESE TERMINI.

(Discontinued services are shown in italics.)

Terminus.		Distance		TRAIN.	Time spent in Vienna.			
From	To	Km.	Miles.		First terminus.	Run.	2nd terminus.	Total.
					Minutes			
West.	Süd.	13.7	8.5	*Ostend-Trieste*	*20*	*37*	*38*	*95*
Do.	Ost.	14.8	9.2	Arlberg-Orient	10	26	14	50
Do.	Nord.	18.9	11.7	*Ostend-Vienna* (1929)	*13*	*26*	*9*	*48*
Süd.	Ost.	7.9	4.9	Rome-Venice-Warsaw	36	12	47	95
Do.	Nord.	12.1	7.5	*St. Petersburg-Cannes*	*41*	*37*	*38*	*116*
Ost.	Nord.	6.3	3.9	Warsaw-Cannes	54	40	96	190

With a few exceptions (1) trains only serve one terminus now.

TABLE 184.

COMPARATIVE RUNS BETWEEN THE DIFFERENT VIENNESE TERMINI AND CERTAIN PROVINCIAL CENTRES.

(Non-stop runs in **heavy type.**)

RUN.	Distance		Time of departure.	Time spent.	Number of stops.	...
	Km.	Miles.				
Vienna S.-Gloggnitz	75	46.6	10.00 p. m.	1.20	1	
Vienna O.- Do.	75	46.6	2.50 p. m.	1.22	...	Vienne - Nice - Cannes Express.
Vienna O.-Bratislava	65	40.4	11.55 a. m.	1.30	3	Express from Kaschau.
Vienna W.- Do.	84	52.2	4.38 p. m.	1.47	1	Orient Express.
Vienna O.-Marchegg	46	28.6	11.55 a. m.	0.43	2	
Vienna W.-Marchegg	71	44.1	4.38 p. m.	1.13	...	Orient Express.
Vienna W.-Heiligenstadt-March.	65	40.4				
Vienna O.-Lundenburg	...	...	10.15 a. m.	1.35	...	Rome-Warsaw.
Vienna N.- Do.	84	52.2	3.20 p. m.	1.13	2	
Vienna O.-Wiener Neustadt (2)	54	33.6	7.40 a. m.	0.54		
Vienna S. -Do. (2)	49	30.4	10.00 p. m.	0.45		
Vienna W. A. -Do.	52	32.3	10.35 a. m.	0.47	...	Motor train.
Vienna W.-Amstetten	125	77.7	10.15 a. m.	2.02	1	
Vienna N.-Lebersdorf-Linz	178	110.6	R6.42 p. m.	4 26	...	Paris - Vienna - Warsaw (1920).
Vienna O.-Nussdorf-Gmund	176	109.4				
Vienna W.-Heiligenstadt-Gmund	174	108.1				
Vienna F.J.-Heiligenstadt-Gmund	164	101.9				
Vienna W.-Hegyeshalom	91	56.5	6.55 p. m.	1.39	1	Via Vienna Ost.
Vienna O.- Do.	72	44.7	7.10 p. m.	1.04	...	Arlberg-Orient Exp.

(1) Rome-Warsaw trains run into Vienna Ost and Nord and do not call at Vienna Süd.

(2) All Budapest expresses from Vienna West run into Vienna Ost, except the Arlberg Orient, which runs straight through to Marchegg.

XXXIII-3. — The sleeping-, restaurant- and saloon-car services. — While the PULLMAN and MANN Companies were still fighting for supremacy in the United States, they were both extending their field of action to Europe. The first sleeping-car services, of the *Mann Boudoir Sleeping Carriage Co.*, were started in Austria as early as 1873, with the assistance of the Belgian Nagelmakers, and the earliest coaches were built at the *Franco-Belge Co.*'s Works at La Croyère (Belgium). They were immediately popular and two years later, 51 sleeping cars were in use on a dozen different services.

The *International Sleeping-Car Co.* took over the existing stock of 58 carriages in 1876, when it was founded. It purchased sleeping cars of a new design (1) also built by the *Franco-Belge Co.*, and exhibited one of them at the Paris Exhibition of 1878 (fig. 184).

TABLE 185.

AUSTRIAN MITROPA SERVICES.

From	via	to	Distance. Km. (2)	Distance. Miles.	Time (hours and tenths).	Distance run in Austria. Km.	Distance run in Austria. Miles.
Vienna West.	Passau.	Berlin Anhalt .	928	576.6	13.7	296	183.9
Do.	Do.	Nuremberg . .	515	320.0	11.2	11	6.8
Do.	Salzburg.	Munich . . .	468	290.8	8.5	314	195.1
Do.	Kufstein.	Berlin Anhalt .	774	481.0	10.8	519	322.5
Badgastein.	Mühldorf.	Do. .	811	503.9	16.6	168	104.4
Bad Reichenh.	Do.	Do. .	712	442.4	12.7	15	9.3

The number of the *Sleeping-Car Co.*'s Austrian services increased very rapidly (fig. 185) and, since the war, have been added to by the *Mitropa,* whose services connect Vienna and certain watering places with Munich, Nuremburg and Berlin.

This Company's Austrian sleeping-car services cover 656 km. (407.6 miles), while the *International Sleeping-Car Company*'s cover 2 015 km. (1 258 miles) in addition to 174 route-km. (108.1 miles) having restaurant-car services only.

In addition it ran a series of « de luxe » trains over 1 480 route-km. (919.6 miles). The oldest of these, the « Orient Express », which ran for the first time on the 5th June 1883, was the prototype for all the others.

Except for the Austro-Russian services, the fixing of the new Austrian frontiers has not had any great effect on the Company's Austrian services.

Mid-way between East and West, the crack trains from Ostend-Amsterdam (« Ostend-Vienna-Orient »), and from Paris Est and Munich (« Orient Express »), join up either at Wels, where the lines meet, or at Linz, (25-km. = 15.5 miles) this last section being common to both the Ostend and Paris lines.

Immediately after the war, it became

(1) These six-wheeled coaches were 9 m. (29 ft. 6 3/8 in.) long and 2.80 m. (9 ft. 2 15/64 in.) wide. At this early date, they were already supplied with hot and cold water, excellent lighting, double windows, and were heated in winter.

(2) According to the *Mitropa* 1934 timetables.

Fig. 184. — Old six-wheeled sleeping car built about 1878, by the *Franco-Belge* Co., in their La Croyère Works.

necessary to connect Paris with Prague and Warsaw without passing through Germany at all; the « Orient Express » was diverted from its original route and sent via Basle to Linz, where it was split up. One section ran to Prague (1919-1921), and the other to Vienna W. and N. (later on to Vienna N. only) and then on to the Polish capital.

As soon as it became possible to re-establish the « Orient Express » through Strasbourg and Munich as formerly, a section of the « Ostend-Vienna-Orient » was run via Luxemburg so as to join it at Strasbourg, but this train soon reverted to its usual route.

A new train, the « Arlberg-Orient Express » has been added since. Started as the « Paris-Switzerland-Vienna Express », a sleeping-car train introduced in 1924, it was soon extended eastwards and now alternates with the « Orient Express », running via Buchs while the latter runs through Strasbourg. The two routes cross each other at Vienna, the « Orient Express » running along the northern bank of the Danube and the « Arlberg Orient » along the southern. The two routes again cross at Budapest.

All the North and South « de luxe » trains have been discontinued, so we will deal with them very briefly.

A « Berlin-Vienna Express » only ran for a very short time (1); it was actually an extension of the Berlin-Carlsbad Express which only ran in summer, and also included a Berlin-Eger-Marienbad section.

The « Nord-Sud-Brenner Express », the *Hamburg Amerika Co.*'s « Ägypten Express », and the « Berlin-Tyrol-Rome Express », which all crossed the Tyrol along the Munich, Innsbruck and Brenner line, have not run since the war. These were merely transit trains.

Relations with Italy and the Riviera

(1) Existed in 1906.

Fig. 185. — Austrian lines served by the International Sleeping-Car Company.

TABLE 186.

AUSTRIAN RUNS OF THE INTERNATIONAL SLEEPING-CAR COMPANY TRAINS.

Run: Origin.	Run: Austrian section.	Run: Destination.	Distance: Km.	Distance: Miles.	Time of departure.	Time spent.	Speed: Km./h.	Speed: Miles/h.	Name of train.	Time spent crossing Vienna. (1)
	North-South transit.									
Hambourg.	*Kufstein-Brenner*	*Naples.*	*111*	*69.0*	*9.45 a. m.*	*2.42*	*41.1*	*25.5*	*Ägypten Express.*	...
Berlin.	*Do.*	*Palermo. Taorm. Riv.*	*111*	*69.0*	*9.15 a. m.*	*2.42*	*41.1*	*25.5*	*Berlin-Rome-Naples Express.*	...
Berlin.	*Do.*	*Rome.*	*111*	*69.0*	*2.27 a. m.*	*2.51*	*39.4*	*24.4*	*Berlin-Tyrol-Rome Exp.*	...
Berlin.	*Do.*	*Milan-Cannes.*	*111*	*69.0*	*9.45 a. m.*	*2.42*	*41.1*	*25.5*	*Nord Sud (Brenner) Express.*	...
	West-East transit.									
Paris. Calais.	Salzburg-Vienna W.-Marchegg	Belgrad. Bucharest.	389	241.7	11.16 a. m.	6.31	59.5	369.7	Orient Express.	1.54
Paris. Boulogne.	Buchs-Vienna W.-Hegyeshalom	Athens. Bucharest.	841	522.6	6.50 a. m.	13.24	51.2	31.8	Arlberg-Orient Express.	0.40
Amsterdam. Ostend.	Passau-Vienna W.-Marchegg	Istanbul. Bucharest.	343	213.1	11.44 a. m.	6.17	54.6	33.9	Ostend-Vienna-Orient Express.	...
Paris Est.	*Buchs-Vienna N.-Lundenburg*	*Warsaw.*	*846*	*525.7*	*2.30 p. m.*	*23.25*	*36.2*	22.5	*Military train* (1920).	2.20
	West-South transit.									
Ostend. Calais.	*Salzburg-Vienna W. S.-Marburg*	*Trieste.*	*740*	*459.8*	*11.37 a. m.*	*19.33*	*37.9*	*23.6*	*Ostend-Trieste* (2).	1.35
	Austria to abroad.									
St. Petersburg.	*Lundenburg-Vienna N. S.-Tarvisio*	*S. Remo-Cannes.*	*493*	*306.3*	*7.0 a. m.*	*11.05*	*44.8*	*27.8*	*St. Petersburg-Vienna-Nice-Cannes Express.*	1.56
...	Vienna O.-Tarvisio	*Do.*	397	246.7	2.50 p. m.	8.15	48.1	29.9	Vienna-S. Remo-Nice-Cannes Express.	...
Budapest.	*Vienna S.-Dobiaco*	*Cannes.*	*520*	*323.1*	*10.50 p. m.*	*12.18*	*42.3*	*26.3*	*Vienna-Tyrol-Riviera (1913).*	...
...	*Vienna S.-Tarvisio*	*Rome-Naples.*	*433*	*269.1*	*4.20 p. m.*	*7.25*	*58.4*	*36.3*	*Vienna-Rome-Naples Express.*	...
...	*Vienna F.J.-Gmund*	*Berlin Anh.*	*164*	*101.9*	*8.45 a. m.*	*2.26*	*66.6*	*41.4*	*Berlin-Vienna Express (1906).*	...

(1) Between time of arrival at the first Viennese terminus and departure from the other.
(2) Over this route, the London-Trieste journey took 45 h. 10 m. This was brought down to 34 hours over the Simplon route.

have been simplified. The « Vienna-Nice-Cannes » has lost its northern part [1] which came from St. Petersburg and Warsaw, with a through sleeping car from Podwoloczisk a (Odessa). It now runs only between Vienna and Cannes, with a special sleeper from Munich, and enters Italy via Tarvisio so as to join the Milan main line at Verona.

Until the war, there was also a *Südbahn* competitive train; this was made up at Marburg with rakes coming from Vienna and Budapest and ran to Bologna and Rome via Dobiaco (Toblach) and Brixen.

CHAPTER XXXIV.

Austrian train speeds.

XXXIV-1. — **General.** — Limited to 100 km. (62 miles) an hour on some lines (and to 110 km. = 68.35 miles in the case of 2-8-4 locomotives) the speed cannot as a rule exceed 90 or 80 km. (56.0 or 49.7 miles) an hour or even less on account of the many small-radius curves in the mountainous districts (150 m. = 7 1/2 chains). The northern lines are easier, maximum gradients reaching 1 in 67 to 1 in 50 only, and as little as 1 in 100 to 1 in 83 between Vienna and Passau. Elsewhere, they are often steeper than 1 in 33.

The main lines are double-track [2], which makes it possible to maintain high speeds over long sections. Curiously enough the fastest train in the country runs over the single-track Linz-Passau line.

Fig. 186. — One of the oldest European bogie carriages, in use about 1842 on the Brünn Railway *(Nordbahn)* (*).

During the season, the weight of the trains used to be considerable and even now, is still fairly high on the Linz-Vienna main line, the 2-6-4 or 4-8-0 locomotives hauling 400- to 450-t. (394 to 443 Engl. tons) trains up 1 in 100 gradients, at a speed of 40 km. (24.9 miles) an hour. But when the weight reached 500 to 550 t. (492 to 541 Engl. tons), double heading had to be resorted to, and to remedy this,

(*) The first bogie carriages were built in the U. S. A. in 1836, in Continental Europe in 1840, and in England in 1873 (first Pullman coaches).

(1) This train ran over the Viennese Outer Circle between the Nord and Süd stations, and took 37 minutes for this journey.

(2) All the double-track lines start from Vienna and radiate towards :

Marchegg	46 km.	(28.6 miles).
Lundenburg (Breclav)	83 km.	(51.6 miles).
Gmund	162 km.	(100.7 miles).
Innsbruck (*Südbahn*)	565 km.	(351.1 miles).
Innsbruck to Brennero	37 km.	(23.0 miles).
Bruck a./M. to St. Veit	153 km.	(95.1 miles).
(Except 12 km. (7.5 miles) from Leoben to St. Michael.)		
Strass-Sommerein (Hegyeshalom)	72 km.	(44.7 miles).
Hainburg	50 km.	(31 miles).
Viennese Circle Line.	—	—

Fig. 187. — Cartogram showing maximum overall speeds on the Austrian railways.

Legend:

over 80 km. (50 miles) an hour.
70 to 80 km. (44 to 50 miles) an hour.
60 to 70 km. (38 to 44 miles) an hour.
under 60 km. (38 miles) an hour.

2-8-4 locomotives [1] were designed (fig. 188). It became possible, between Vienna and Salzburg, to save an hour on the previous timings of the six-coupled locomotives, and this without exceeding the speed limit of 100 km. (62 miles) an hour.

XXXIV-2. — **Electric traction.** — Electrification of the mountain lines is being carried out in stages, according to the standards of the Swiss and Bavarian railways with which they link up (15 000 volts, 16 2/3 periods).

880 km. (546.9 miles) have already been electrified :

	Km.	Miles.
Salzburg-Schwarzach-Mallnitz-Wörgl	261	162.2
Südbahn : Wörgl-Innsbruck	60	37.3
Do. : Wörgl-Kufstein	13	8.1
Do. : Innsbruck-Brennero	37	23.0
Innsbruck-Feldkirch-Bregenz	175	108.7
Feldkirch-Buchs	37	30.0
Attnang-Stainach	107	66.5
Vienna-Frontier (near Hainburg)	43	26.7
Mödling-Hinterbruck	4	2.5
St. Pölten-Gusswerk (metre gauge)	91	56.5
Innsbruck-Mittenwald	65	40.4

There are, besides, several electric local lines, mostly suburban lines or railways running up hilly valleys.

Table 191 shows the most interesting runs on electrified sections, as well as the fastest and the longest non-stop runs.

XXXIV-3. — **Rail motor vehicles.** — Operation with rail motor vehicles has developed very rapidly for three kinds of services : long fast runs, local main line services and secondary line services.

They are run either alone, or with one or two trailers.

Some of the services are very long, and many of them include runs made at some 70 km. (43.5 miles) an hour average speed.

The first international high-speed service worked by Ganz rail motor coaches has recently been inaugurated between Budapest and Vienna and we understand it is to be duplicated with an Austrian fast railcar.

Such services are operated by means of *Austro-Daimler* railcars and others supplied by various firms (figs. 189-190).

The *Austro-Daimler* railcars have double wheels with pneumatic tyres and 6-cylinder engines (figs. 191 to 194). The vehicles are very low, which increases their stability (fig. 196). It is interesting to compare them from this point of view with similar French vehicles [2] (fig. 197). Identical units have been supplied to the Polish Railways.

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[1] From the point of view of speed, these locomotives had to comply with the following conditions :

Reach a speed of 90 km. (56 miles) an hour, on the level, in two minutes; a speed of 60 km. (37.3 miles) an hour on a 1 in 100 gradient, and a maximum speed of 110 km. (68.4 miles) an hour.

Limitations applied to the axle load, which might not exceed 18 t. (17.7 Engl. tons) and the boiler pressure, was to be 15 kgr./cm² (213.3 lb. per sq. inch) only.

Empty, these locomotives weigh 106 to 108 t. (104.3 to 106.3 Engl. tons) according to whether they have 2 or 3 cylinders, and in running order 118 t. (116.1 Engl. tons).

[2] See *Bulletin of the Railway Congress*, May 1934, p. 432/176.

Table 187.

AUSTRIAN RAIL MOTOR VEHICLE SERVICES.

(Non-stop runs are shown in **heavy type.**)

RUN.	Distance. Km.	Distance. Miles.	Time of departure.	Time spent.	Speed. Km./h.	Speed. Miles/h.	Train.
Vienna N.-Lundenburg	83.2	51.7	3.20 p. m.	1.13	66.4	41.3	T Eilzug 91.
Vienna N.-Gänserndorf . . .	32	19.9	**3.20** p. m.	**0.29**	**66.2**	**41 1**	Do.
Hohenau-Lundenburg	19	11.8	**4.17** p. m.	**0.16**	**71.2**	**44.2**	Do.
Vienna F.J.-Krems-Grein . . .	128	79.5	8.40 a. m.	3.10	40.1	24.9	T Eilzug 141.
Vienna F.J.-Krems	75.4	46.9	**8.40** a. m.	**1 07**	**67.5**	**41.9**	Do.
Heiligenstadt-Krems	73	45.4	**R7.16** a. m.	**1.01**	**71.8**	**44.6**	T Eilzug 144.
Vienna S.-Bruck-Graz	211	131.1	7.20 p. m.	3 27	61.2	38.0	TS 183 2 stops.
Vienna S.-Payerbach	82	51.0	7.20 p. m.	**1.08**	**72.2**	**44.9**	Do.
Do. -Semmering	103	64.0	**R8.30** a. m.	**1.33**	**65.7**	**40.8**	TS 184.
Semmering-Mürzzuchlag . . .	14	8.7	9.10 p. m	**0.14**	**60.0**	**37.3**	TS 183.
Mürzzuchlag-Bruck a./M. . .	41	25.5	**9.26** p. m.	**0.32**	**69 4**	**43.1**	Do.
Bruck a./M.-Graz	53	32.9	**10.00** p. m.	**0.47**	**67.7**	**42.1**	Do.
Graz-Selzthal-Bischofshofen . .	297	184.6	3.20 p. m.	4.55	60.4	37.5	TS 248.
Bruck-Leoben	17	10.6	**4.12** p. m.	0.15	**68.0**	**42.3**	TS 248/257.
Leoben-Selzthal	76	47.2	**4.28** p. m.	**1.14**	**61.6**	**38.3**	Do.
Selzthal-Bischofshofen . . .	98	60.9	**5.52** p. m.	**1.33**	**63.2**	**39.3**	Do. 3 st.
Bischofshofen-Salzburg . . .	53	32.9	**7.30** p. m.	**0.45**	**70.7**	**43.9**	Do.
Vienna Asp.-Aspang *(Company)*.	87	54.1	10.35 a. m.	1.29	56.4	35.0	TS 3 Aspang B.
Vienna Asp.-Wiener Neustadt .	52	32.3	**10.35** a. m.	**0.46**	**67.8**	**42.1**	Do.
« Eilzüge ».							
Vienna W.-Linz-Innsbruck-Lindau	769	477.8	7.20 p. m.	24.30	31.3	19.4	Eilzug 139.
Do. -Innsbruck . . .	565	351.1	7.25 a. m.	11.50	29.8	18.5	Do. 131.
Do. -Salzburg . . .	314	195.1	5.00 p. m.	6.18	49.8	30.9	Do. 105.
Do. -Linz	189	117.4	2.30 a. m.	3.28	54.5	33.9	Do. 363. 6 st.
Vienna W.-Rekawinkel	25	15.5	**2.30** a. m.	**0.33**	**35.5**	**22.1**	Do. 363.
Do. -St. Pölten	61	37.9	7.25 a. m.	1.02	59.0	36.7	Do. 131.
Vienna S.-Bruck a./M.-Leoben-Villach	369	229.3	12.00 noon	7.48	47.1	29.3	Do. 283.
Leoben-Knittelfeld	35	21.7	**3.46** p. m.	**0.31**	**67.7**	**42.1**	Do.
Vienna S.-Mürzzuchlag-Bruck a./M.	158	98.2	2.25 a. m.	3.23	46.4	28.8	T Eilzug 657.
Vienna S.-Felixdorf	40	24.8	2.25 a. m.	**0.45**	**54.0**	**33.6**	Do.
Austro-Hungarian international service.							
Vienna O.-Strass-Sommerein . .	72	44.7	**R9.19** a. m.	**0.51**	**84.7**	**52.6**	Hungarian railcar.

They are sometimes used single, sometimes coupled together in twos, with or without an intermediate trailer (1).

(1) The triple vehicle has 85 × 115 mm. (3 11/32 in. × 4 33/64 in.) cylinders. Power developed : 60 H.P. at 2 000 r. p. m.; 75 H.P. (max. 80) at 3 000 r. p. m.

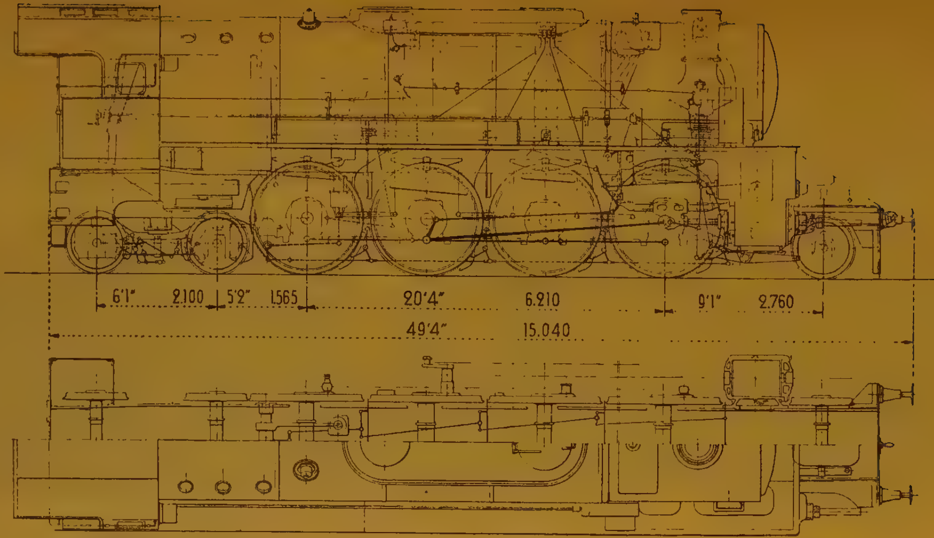


Fig. 188. — 2-8-4 locomotive, Austrian Federal Railways.

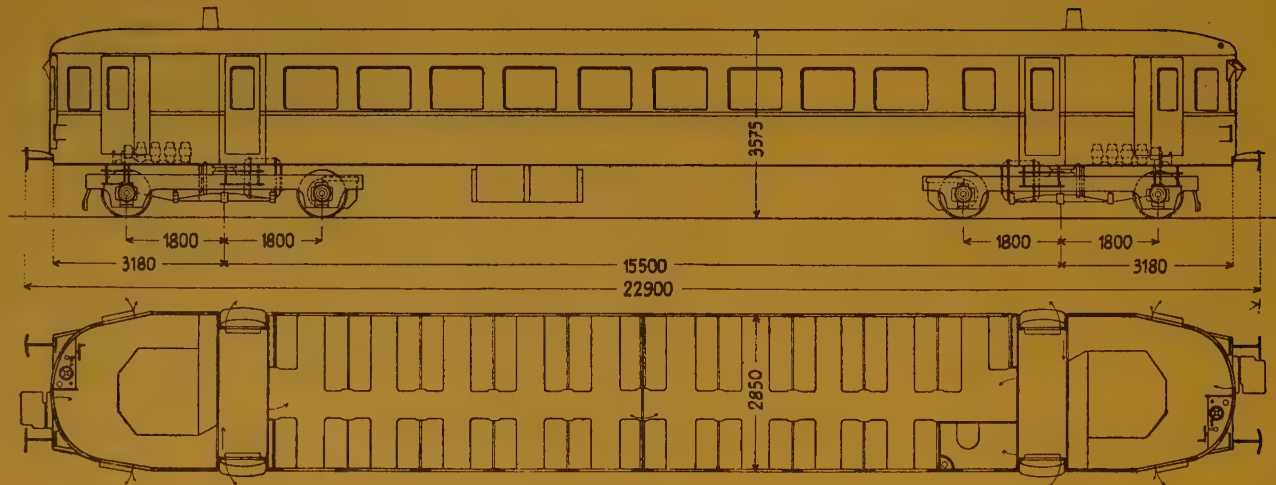


Fig. 189. — Rail motor car of the Austrian Federal Railways, built at the Simmering Works.

TABLE 188.
LEADING DIMENSIONS OF THE AUSTRO-DAIMLER RAIL CARS.

BUILDER.	Austro-Daimler.			
Number of wheels Number of seats	4 32	4 40	8 70+5 tip-up.	8 56+4 tip-up.
Overall length	10.240 m. (33′ 7 5/32″)	11.720 m. (38′ 5 7/16″)	16.600 m. (54′ 5 9/16″)	21.700 m. (71′ 2 11/32″)
Body, outside width	2.380 m. (7′ 9 23/32″)	2.380 m. (7′ 9 23/32″)	2.400 m. (7′ 10 15/32″)	2.500 m. (8′ 2 7/16″)
Body, outside height from rail level	2.680 m. (8′ 9 7/16″)	2.650 m. (8′ 8 11/32″)	2.960 m. (9′ 8 9/16″)	2.680 m. (8′ 9 7/16″)
Wheel diameter	1.030 m. (3′ 4 9/16″)	1.030 m. (3′ 4 9/16″)	1.030 m. (3′ 4 9/16″)	1.030 m. (3′ 4 9/16″)
Bogie wheelbase	...	...	1.600 m. (5′ 3″)	2.400 m. (7′ 10 15/32″)
Distance between bogie centres	...	...	12.000 m. (39′ 4 7/16″)	17.000 m. (55′ 9 1/4″)
Wheel base (4-wheeled cars)	5.200 m. (17′ 3/4″)	6.680 m. (21′ 11″)	...	...

Though intended for local services, the first three types nonetheless attain quite high speeds. The first of them has a maximum speed of 100 km. (62 miles) an hour and can stop in the following distances :

Within 110 m. (120 yards) from 80 km. (49.7 miles) an hour on the level.

Within 65 m. (71 yards) from 65 km. (40.4 miles) an hour running down a 1 in 40 gradient).

Within 50 m. (55 yards) from a speed of 50 km. (49.7 miles) an hour running down a 1 in 25 gradient.

The fourth type is a rail motor coach for fast trains, and is used on the Semmering line.

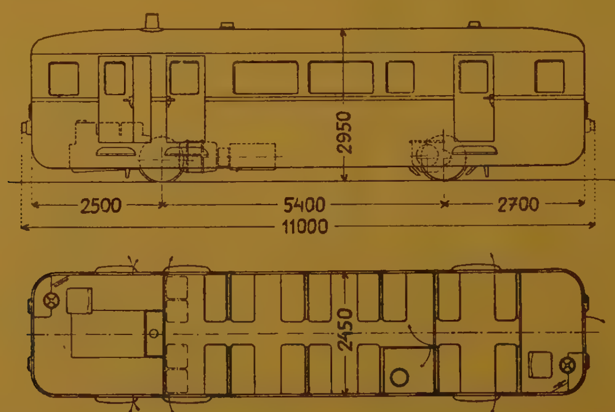
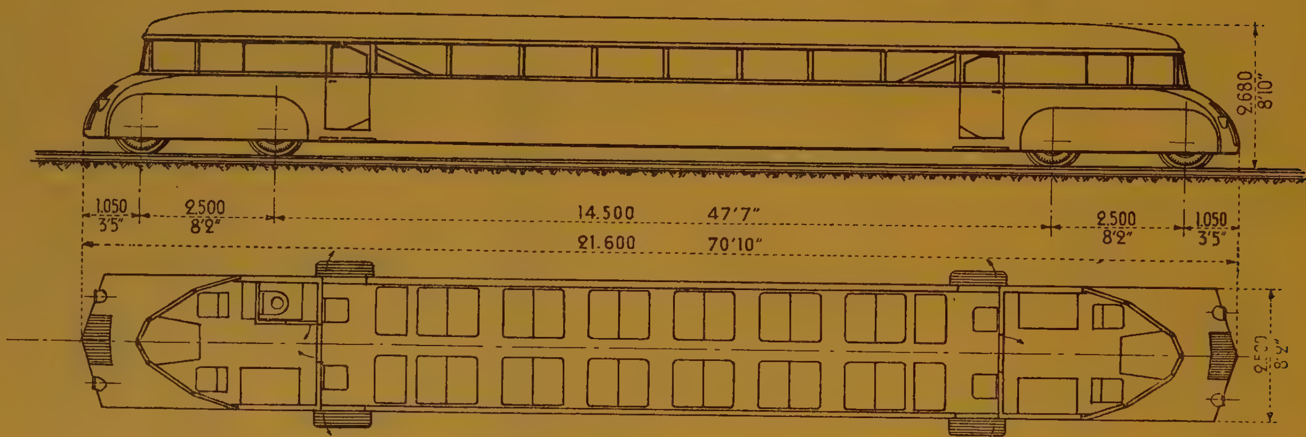


Fig. 190. — Type A. 11. 90 railcar of the Austrian Federal Railways, built at the Simmering Works.



Figs. 191-192. — High-speed Austro-Daimler diesel railcar, Austrian Federal Railways.

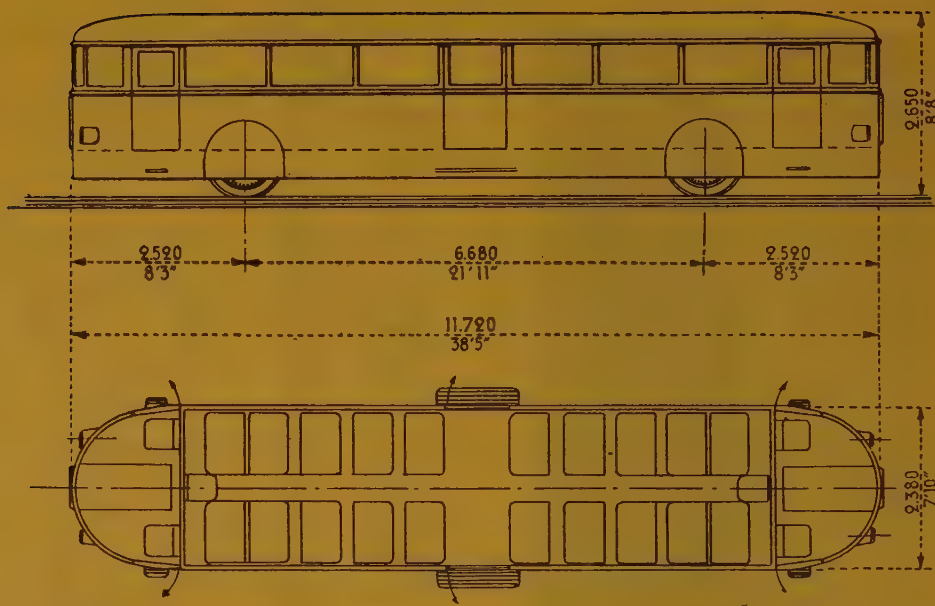


Fig. 193. — Four-wheeled Austro-Daimler railcar, Austrian Federal Railways.

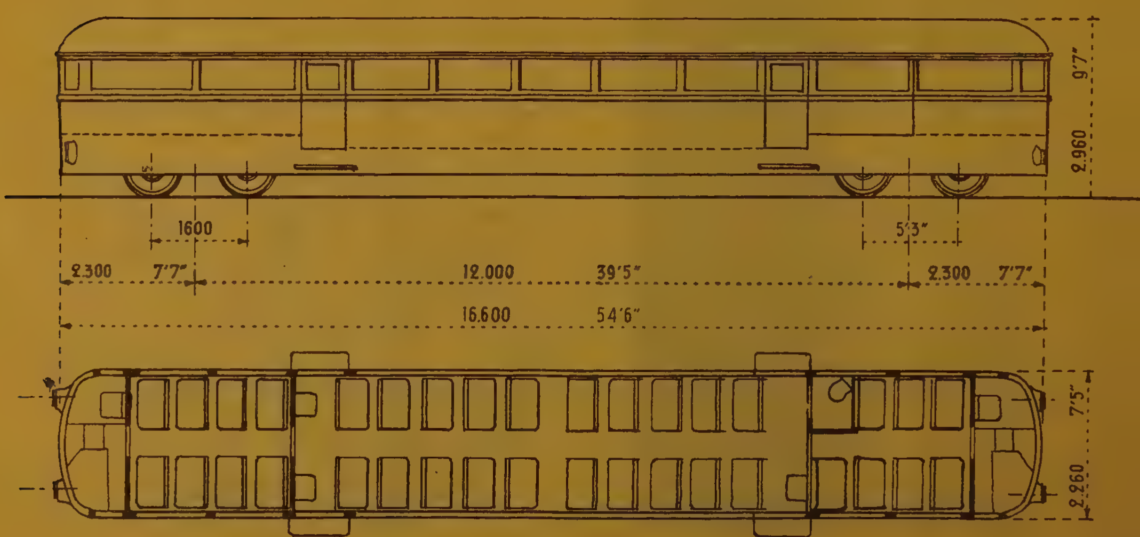


Fig. 194. — Austro-Daimler bogie railcar, Austrian Federal Railways.

Fig. 195. — Map of Austria showing the main lines and secondary lines worked by Austro-Daimler railcars.

Legend: ▬ = Main lines. —— = Secondary lines.

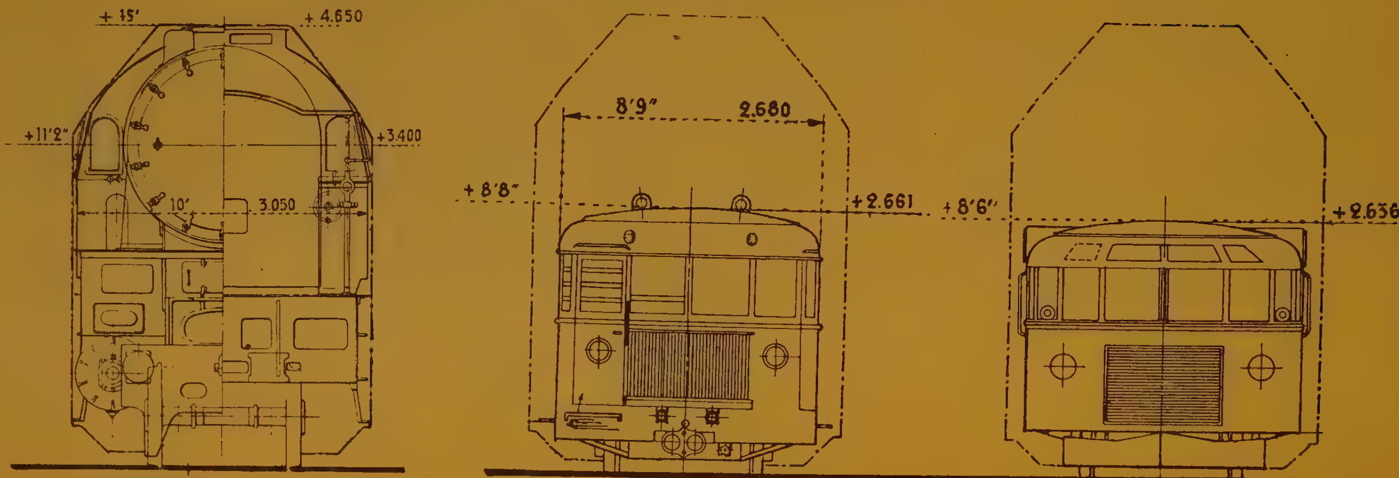


Fig. 196. — Austrian loading gauge showing space taken up by the high speed and ordinary Austro-Daimler railcars

TABLE 189.

LEADING DIMENSIONS OF AUSTRIAN RAIL MOTOR COACHES.

BUILDER.	FLORIDSDORF.		SIMMERING.				
			—	(*)	(*)	(*)	—
Number of wheels	4	8	4	4	6	8	8
Carrying capacity	60 + 20	76+30 stand.	30 + 4	50 + 3	46 + 5	94 + 6	86 + 4
Body, overall length	13.600 m. (44′ 6″)	17.800 m. (58′ 4 25/32″)	11.000 m. (36′ 1″)	12.920 m. (42′ 4 11/16″)	13.150 m. (43′ 1 11/16″)	21.700 m. (71′ 2 11/32″)	19.400 m. (63′ 7 25/32″)
— outside width	3.034 m. (9′ 11 11/16″)	3.034 m. (9′ 11 11/16″)	2.450 m. (8′ 15/32″)	3.000 m. (9′ 10 1/8″)	2.920 m. (9′ 7″)	2.900 m. (9′ 6 3/16″)	2.860 m. (9′ 4 19/32″)
— outside height from rail level	...	...	2.950 m. (9′ 8 5/32″)	3.500 m. (11′ 5 25/32″)	3.570 m. (11′ 8 9/16″)	3.575 m. (11′ 8 3/4″)	3.100 m. (10′ 2″)
Wheel diameter	...	...	...	...	...	...	...
Bogie wheelbase	...	2.500 m. (8′ 2 7/16″)	...	...	3.600 m. (11′ 9 3/4″)	3.500 m. (11′ 5 25/32″)	3.600 m. (11′ 9 3/4″)
Distance between bogie centres.	...	11.000 m. (36′ 1″)	...	...	7.000 m. (22′ 11 5/8″)	15.660 m. (51′ 4 9/16″)	13.400 m. (43′ 11 9/16″)
Wheel base (4-wheeled cars) .	7.000 m. (22′ 11 5/8″)	...	5.400 m. (17′ 8 19/32″)	6.750 m. (22′ 1 3/4″)	...	...	...
Weight empty . . . . . M. t. (Engl. t.).	...	...	11 (10.8)	15 (14.76)	22 (21.65)	33.4 (32.9)	21 (20.7)
Weight in working order, with passengers . . . . . . M. t. (Engl. t.).	...	...	14 (13.8)	20.5 (20.2)	27 (26.6)	42 (41.4)	35 (34.5)
Weight in working order, without passengers . . . M. t. (Engl. t.).	20 (19.7)	30 (29.5)	...	...	...	...	...
Weight per place . . . M. t. (Engl. t.).	0.333 (0.328)	0.382 (0.376)	0.324 (0.319)	0.280 (0.275)	0.431 (0.424)	0.331 (0.326)	0.233 (0.229)
Weight per seat . . . M. t. (Engl. t.).	0.250 (0.246)	0.283 (0.278)	0.367 (0.361)	0.300 (0.295)	0.478 (0.470)	0.351 (0.345)	0.244 (0.240)
Maximum speed . . Km./h. (Miles/h.).	...	...	90 (55.9)	78 (48.5)	88 (54.7)	98 (60.9)	90 (55.9)
Engine horse-power	...	...	90	125	175	2 × 175	175

TABLE 190.

NOTEWORTHY AUSTRIAN TRAIN RUNS (fig. 187).

Non-stop runs are shown in **heavy type**; obsolete runs *in italics*.

RUN.	Distance. Km.	Distance. Miles.	Time of departure.	Time spent.	Speed. Km./h.	Speed. Miles/h.	—
Vienna W.-Budapest W.	275	170.9	4.38 p. m.	4.57	55.5	34.5	Orient Expr. 2 stops.
Vienna W.-Marchegg	65	40.4	**4 38 p. m.**	**1.13**	**53.4**	**33.2**	Do.
Vienna O.- Do.	46	28.6	**11.55 a. m.**	**0.43**	**64.2**	**39.9**	
Vienna N.-Lundenburg (Breclav) (Prague)	83	51.6	2.00 p. m.	1.16	65.5	40.7	2 stops.
Vienna O.-Lundenburg (Breclav) (Prague)	90	55.9	**10.15 a. m.**	**1.25**	**63.5**	**39.5**	
Vienna N.-Retz-Znaim-Iglau-Prague	363	225.6	R 7.25 a. m.	9.00	40.6	25.2	4 stops.
Vienna N.-Retz	82	51.0	**9.13 p. m.**	**1.38**	**50.2**	**31.2**	
Vienna N.-Znaim	101	62.8	...	...	...	...	
Vienna F.J.-Gmund-Ceske Velenice-Prague-Berlin	729	452.9	R 9.53 a m.	10.22	50.3	31.3	
Vienna-Ceske Velenice	164	101.9	R 7.41 p. m.	2.34	63.9	39.7	5 stops (Berlin).
Vienna F.J.-Tulln	33	20.5	**2.05 p. m.**	**0.31**	**63.9**	**39 7**	
Do. -Eggenburg	79	49.1	**7.25 a. m.**	**1.15**	**63.2**	**39 3**	
Do. -Sigmundsherberg	89	55.3	**10.15 a. m.**	**1.24**	**63.5**	**39.5**	
Heiligenstadt-Sigmundsherberg	86	55.4	**R 6.37 p. m.**	**1.18**	**66.2**	**42.4**	
Sigmundsherberg-Göpfritz	33	20.5	**R 12.12 p. m.**	**0.26**	**76.2**	**47.3**	
Do. -Schwarzenau	49	30.4	**R 10 37 a. m.**	**0.41**	**71.7**	**44.6**	
Vienna W.-Linz-Passau (Brussels)	296	183.9	R 11.12 a. m.	4.43	59.2	36.8	Ostend-Vienna 2 st.
Linz-Passau	107	66.5	R *12.34* p. m.	*1.34*	*77.3*	*48.0*	*Do.*
Linz-Wels	25	15.5	**R 5.58 a. m.**	**0.20**	**75.0**	**46.6**	
Wels-Passau	82	51.0	**R 11.42 a. m.**	**1.03**	**77.8**	**48.3**	Do.
(Wels) Grieskirchen-Schärding	48	29.8	**10.34 p. m.**	**0.36**	**80.0**	**49.7**	
Vienna W.-Linz-Salzburg-Buchs	741	460.4	12.20 p. m.	11.40	63.4	39.4	Arlberg Orient.
Do. Do. -Bludenz	702	436.2	12.20 p. m.	11.02	63.9	39.7	Do. 17 stops.
Do. Do. -Innsbruck	565	351.1	12 20 p. m.	8.25	64.1	39.8	Do. 5 stops.
Do. -Salzburg	314	195.1	12.20 p. m.	4.20	72.5	45 1	Do. 2 stops.
Vienna W.-St. Pölten	61	37.9	**8.00 a. m.**	**0.54**	**68.0**	**42.3**	
Vienna W.-Linz	189	117.4	**12.20 p. m.**	**2 27**	**77.2**	**48.0**	Do.
St. Pölten-Linz	128	79.5	**8.56 a. m.**	**1.34**	**81.7**	**50.8**	
Linz-Salzburg	125	77.7	**R 2.10 p. m.**	**1.43**	**72.8**	**45.2**	Do.
Wels-Salzburg	100	62.1	**R 11.16 a. m.**	**1.26**	**70.0**	**45.3**	Orient Express.
Salzburg-Schwarzach-St. Veit	67	41.6	**4.50 p. m.**	**1.09**	**68.1**	**42 3**	
Wörgl-Jenbach	25	15.3	**11 03 p. m.**	**0.20**	**75.0**	**46 6**	
Wörgl-Innsbruck	59	36.7	**R 6.50 p. m.**	**0.49**	**71 8**	**44 6**	
Innsbruck-Landeck	72	44.7	**R 8 51 a. m.**	**1.01**	**72.5**	**45.1**	
Feldkirch-Bludenz	21	13.0	**7.10 a. m.**	**0.17**	**74.1**	**46.0**	
Amstetten-Linz-Bischofshofen	242	150.4	3.52 p. m.	4.21	55.6	34.5	7 stops.
Amstetten-Selzthal-Bischofshofen	218	135.5	R 2 27 a. m.	4 23	49.7	30.9	8 stops.
Vienna S.-Bruck a./M.-Villach-Tarvis	397	246.7	10.00 p. m.	8 40	45.8	28 5	
Vienna S.-Mürzzuchlag-Graz-Marburg	277	172.1	8 00 a. m.	5.40	48.9	30.4	
Vienna S.-Wiener Neustadt	49	30.4	**8.00 a. m.**	**0.43**	**65 3**	**40.6**	
Vienna Neustadt-Gloggnitz	27	16.8	**R 8.01 a. m.**	**0 21**	**77.2**	**48.0**	
Vienna O.-Strass Sommerein (Hegyeshalom)	72	44.7	**R 10.37 a. m.**	**1.03**	**68.6**	**42.6**	Arlberg Orient.
Vienna W.-Vienna O.	15	9.3	**4.10 p. m.**	**0.24**	**37.5**	**23.3**	
Vienna O.-Bruck/Leitha	41	25.5	**11.15 a. m.**	**0.37**	**66.5**	**41.3**	

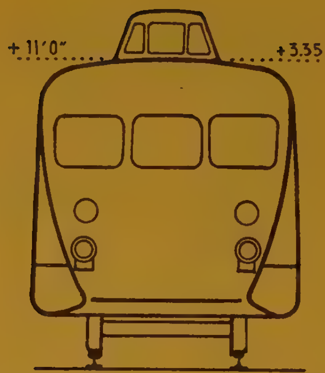


Fig. 197. — End view of Renault fast railcar.

The four-wheeled vehicles designed by the *Floridsdorf Company* are used with one or two trailers, each of which weighs 10 tons empty and 12 tons with the passengers. Their bogie rail motor coaches can haul one to three trailers.

Vehicles designed by the *Simmering Works* are used between Vienna and the Czechoslovakian frontier, and from Lindau to St. Margrethen, usually with a couple of trailers weighing 15 tons (See table 189*).

Diesel-electric rail motor vehicles are also used for the goods services. These

Table 191.

FASTEST RUNS AND LONGEST NON-STOP RUNS.

RUN.	Distance Km.	Distance Miles.	Time of departure.	Time spent.	Speed Km./h.	Speed Miles/h.	
FASTEST NON STOP RUNS.							
Steam traction.							
(Vienna W.) St. Pölten-Linz	128	79.5	8.56 a. m.	1.34	81.7	50.8	
(Wels) Grieskirchen-Schärding	48	29.8	10.34 p. m.	0.36	80.0	49.7	
Wels-Schärding	67	41.6	5.05 a. m.	0 51	79.0	49.0	
Wels-Passau	82	51.0	R 11 42 a. m.	1.03	77.8	48.3	
Vienna W.-Linz	189	117.4	12.20 p. m.	2.27	77.2	48.0	Arlberg Orient.
(Vienna S.) Wr. Neustadt-Gloggnitz	27	16.8	R 8.01 a. m.	0.21	77.2	48.0	
(Vienna F.J.) Sigmundsherberg-Göpfritz	33	20.5	R 12.12 p. m.	0 26	76.2	47.3	
Electric traction.							
(Salzburg) Wörgl-Jenbach	25	15.5	11.03 p. m.	0.20	75.0	46.6	
(Innsbruck) Feldkirch-Bludenz	21	13.0	7 10 a. m.	0.17	74.1	46.0	
Innsbruck H.B.-Ötztal	56	34.8	6.45 p. m.	0.37	74.6	46.4	
Railcars.							
Vienna O.-Strass-Sommerein	72	44.7	R 9.19 a. m.	0.51	84.7	52.6	Hungarian railcar.
Vienna S.-Payerbach (Graz)	82	51.0	7.20 p. m.	1.08	72.2	44.9	
(Vienna F.J.) Heiligenstadt-Krems	73	45.4	R 7.16 p. m.	1.01	71.8	44.6	
(Vienna N.) Hohenau-Lundenburg	19	11.8	4.17 p. m.	0.16	71.2	44.2	
(Graz) Bischofshofen-Salzburg	53	32.9	7.30 p. m.	0.45	70.7	43.9	
LONG NON-STOP RUNS.							
Vienna W.-Linz	189	117.4	12 20 p. m.	2.27	77.2	48.0	Arlberg Orient.
(Vienna W.) Linz-Salzburg	125	77.7	R 2.10 p. m.	1.43	72.8	45.2	Ostend-Vienna.
(Vienna W.) Linz-Passau	107	66.5	R 12.34 p. m.	1.34	77.3	48 0	*Ostend-Vienna.*
Vienna S.-Semmering	103	64.0	R 8.30 a. m.	1.33	66.5	41.3	Railcar.
Salzburg-Schwarzach-St. Veit	67	41.6	4.50 p. m.	1.09	68.1	42.3	Electric traction.

are four-wheeled vans supplied by the *Graz Works*, which in the Viennese suburbs, haul up to 4 vehicles weighing 18 tons.

XXXIV-4. — **Ferryboat lines.** — In order to complete the Arlberg line by through services to Germany, a branch was built from Feldkirch to Bregenz, on the Lake of Constance and ferryboats ply between this place and Bregenz and between Bregenz and Friedrichshafen, thus giving a through service with the Bavarian and Wurtemberg railways.

XXXIV-5. — **Noteworthy train runs.** — Interesting speeds, as well as the fastest and longest non-stop runs are shown in the usual tabular form (tables 190 and 191).

This information, represented in figure 187, is summarised in table 192.

XXXIV-6. — **Conclusions.** — If the mountainous nature of the country be taken into account, it will be noticed that the percentage of the total length of standard-gauge track run over at more than 60 km. (37.3 miles) an hour, i.e. 1 923 km. (1 195 miles), is relatively high as it is more than one third of the system (34 %).

Table 192.

MILEAGE AND PROPORTION OF AUSTRIAN LINES RUN OVER AT VARIOUS OVERALL SPEEDS.

Mileage.	Speed.		Km. of lines.	Percentage of standard gauge lines.
	Miles per hour.	Km. per hour.		
109	50 to 55.9	80 to 89.9	176	3
535	44 to 49.9	70 to 79.9	861	16
550	38 to 43.9	60 to 69.9	886 (1)	17
2 126	Under 38	Under 60	3 422	64
3 320	Standard gauge. TOTAL.	Standard gauge.	5 345	100
315	Narrow gauge. TOTAL.	Narrow gauge.	507	

(1) Including 52 km. (32 miles) of the *Wien-Aspangbahn*.

APPENDIX.

XXXIV-7. — **Rack railways.** — Apart from a few tourist lines (1) there is only one all-rack railway in Austria, used for general traffic, besides a couple of mixed lines.

The *Schneebergbahn*'s (2) Abt metre-gauge railway is 9 746 m. (6.05 miles) long, and has gradients ranging between 1 in 143 to 1 in 5. The 0-4-2-T locomotives, weighing 18 tons in running order and 14 light, haul the 16 to 18-ton trains at a maximum speed of 10 km.

(1) The standard-gauge *Kahlenberg Railway*, near Vienna, opened in 1874, is 5 km. (4.9 miles) long and climbs 280 m. (918 feet). The maximum gradient is 1 in 10.

(2) The Puchberg-Hochschneeberg line climbs 1 218 m. (3 996 feet) and reaches this height in 12 km. (7.5 miles) over maximum gradients of 1 in 5.

(6.2 miles) an hour up, and 8 km. (4.9 miles) an hour down the mountain (1).

The most important mixed line is the *Vordernbergbahn*, which we have already mentioned (XXXII-1). A second line is only about 12 km. (7.5 miles) long between Jenbach and the Achensee, and includes 4 971 m. (3.1 miles) of Riggenbach rack (2).

XXXIV-8. — **Funicular railways.** — Although there is actually only one funicular railway in present-day Austria, the Tyrol was the telpher's playground *par excellence* and the first lines of the kind, about a dozen in number, were soon located there. Some of these, such as the *Hafelekarspitze*'s (2 260 m. = 7 415 feet) or the *Zugspitze*'s (2 805 m. = 8 202 feet) reach an altitude of over 2 000 m. (6 560 feet). Several of them rise more than 1 000 m. (3 280 feet) above sea level in a relatively short distance (3). This implies a running speed frequently exceeding 2.50 m. (8.2 feet) per second (4).

---

(1) On the downward run a speed of 10 km. (6.2 miles) an hour is allowed with empty trains.

(2) The *Achenseebahn* only reaches a maximum altitude of 932 m. (3 058 feet).

(3) Here are some examples :

The *Wankbahn*	3 346 ft.	From 2 444 ft. to 5 790 ft. altitude.
The *Nordkettenbahn* (Innsbruck)	3 429 ft.	From 2 821 ft. to 6 250 ft. altitude.
The *Schmittenhöhenbahn* (Zell am See) .	3 990 ft.	From 2 467 ft. to 6 457 ft. altitude.

(4) This is the *Zugspitze* funicular, on the Austrian side, where the vehicles only take 20 minutes to cover its 3 375 m. (2.1 miles).

VIII. — HUNGARY.

SUMMARY.

CHAPTER XXXV.

XXXV-1. — **General.** — As Hungary is above all a country of wide plains, its railway system is much centred on the capital, from which some ten express lines and half a dozen local lines radiate.

Although most of their peripheral sections were severed by the Treaty of Trianon, these railways have kept their original characteristics, which explains why so many of them are still served by express trains.

Table 193.

SHORTENING OF THE HUNGARIAN RADIATING LINES.

Before the Treaty of Trianon.	Km.	Miles.	At present.	Km.	Miles.
From Budapest to			*From Budapest to*		
Marchegg	232	144.0	Szob	63	39.1
Orsova-Verciorova	497	308.8	Szeged-Szöreg	196	121.8
Lawoczne	435	270.3	Satoral-Jaujhely	268	166.5
Predeal	762	473.5	Biharkeresztes	230	142.9
Zemun-Beograd	359	223.1	Kelebia	163	101.3
Bruck-Kiralyhida	228	141.7	Hegyeshalom	196	121.8

Timetables. — The official timetables for the 1934 summer have been used.

Tariff distances. — As a rule, Hungarian railway rates are based on actual distances, the only exceptions being those including the *State Rys.'* Danube bridges (which lengthen tariff distances by 8 km. = 4.9 miles) and the *Györ-Sopron-Ebenfurt Ry.*'s Györ railway bridge, an additional 6 km. (3.7 miles) being tagged on.

Budapest termini. — As several trains have another than the usual Budapest terminus (fig. 198), we quote these exceptional distances hereafter :

	Km.	*Miles.*
Nyugati (West)-Kelebia (1)	174.446	108.4
Keleti (Ost)-Hatvan	68.536	42.6
Sud (Deli)-Keszthely	189.935	118.1
Keleti (Ost)-Budapest Kelenföld	12.639	78.3

	Km.	*Miles.*
Nyugati (West)-Budapest-Ost	18.691	11.2
Nyugati (West)-Szolnok	100.710	62.5
Nyugati (West)-Kishöros	118.000	73.3
Nyugati (West)-Nagykorös	90.000	55.9

(1) Distance from Kelebia to Kelebia frontier : 3.284 km. (2.04 miles).
The distance from Györ to Enese is 16.265 km. (10.1 miles).

XXXV-2. — Constitution of the railway system.—The *Royal Hungarian State Railways* operate the greater part of the system, i. e. 7 820 km. (4 859 miles) which include, since 1932, the lines of the *Danube-Save-Adriatic Ry. Co.* which, in 1920, has succeded to the Hungarian *Südbahn*, this international Company's Austrian lines having been taken over by the *State* soon after the armistice (1). (See fig. 182.)

The only Companies of any importance which still operate their own lines are :

	Km.	Miles.
Györ-Sopron-Ebenfurt . . .	231	(143.5).
Czeged-Csanad	127	(78.9).
Mohacs-Pecs	55	(34.2).

Alternative lines. — There are two lines from Budapest to Szolnok, one running from the Budapest East, and the other from the West station. They are practically identical in length and they both carry sections of the *International Sleeping Car Co.*'s Near-East trains.

Fig. 198. — Budapest suburban lines and the crossing of Budapest by the International Sleeping-Car Co.'s trains. (Obsolete services are shown in thick dotted lines.)

TABLE 194.

ALTERNATIVE HUNGARIAN LINES.

ROUTE.			Distance. Km.	Distance. Miles.	Time of departure.	Time spent.	Speed. Km./h.	Speed. Miles/h.	—
Budapest	Nyugati-Cegled	Szolnok	101	62.8	10.05 p. m.	1.33	65.2	40.5	1 stop.
Do.	Keleti-Ujszasz		100	62.1	12.01 a. m.	1.42	58.8	36.5	2 stops.
Budapest	Keleti-Kaposvar	Siófok . . .	303	188.3					
Do.	Deli-Szabadbattyan		115	71.5	R 6.13 a. m.	1.40	60.0	37.3	3 stops; Balato Express.
Budapest	Keleti-Hegyeshalom	Vienna Ost . .	271	168.4	7.50 a. m.	3.50	70.7	43.9	Arlberg Express.
Do.	Nyugati-Szob	Vienna West. .	275	170.9	9.13 a. m.	4.58	55.4	34.4	Orient Express.
Do.	Petöfiter Danube	Vienna Praterkai	282	175.2	6.00 p. m.	21.15	12.8	8.0	Boat.
		Do.	Do.	Do.	R 8.30 a. m.	12.15	23.0	14.3	Do.

(1) The Italian lines of the *Südbahn* were taken over in 1875.

Competing lines. — Since the railway nationalisation, there has been no internal competition between Hungarian railways, but such was not previously the case. Thus, formerly, the *Südbahn*'s main line crossed the *State Ry.*'s at the Budapest suburban Kelenföld station and, after skirting Lake Balaton, ran on to Nagykanisza and Agram (Zagreb), while the *State* line passed via Ujdombovar and Gyekenyes. This latter international service has now been abandoned in favour of the former, the distance from Budapest to Agram being respectively 355 km. (221 miles) by the *Südbahn* route and 387 km. (241 miles), over the *State* lines.

Keen competition still takes place on the Budapest-Vienna route, between the railways running along the southern and northern banks of the Danube.

Austrian interests are not so very dissimilar either way, the Austrian runs being respectively 83 km. (51.6 miles) (1) and 46 km. (28.6 miles) (2) long, along the southern or the northern routes, but Hungary's interest in them is very different, the sections lying within its boundaries being respectively 188 km. (116.8 miles) and 63 km. (39.1 miles) (3) (fig. 199) long, besides the fact that they cross an intermediate country (Czechoslovakia), along 167 km. (103.8 miles) of the northern route.

There is, in addition, a river service

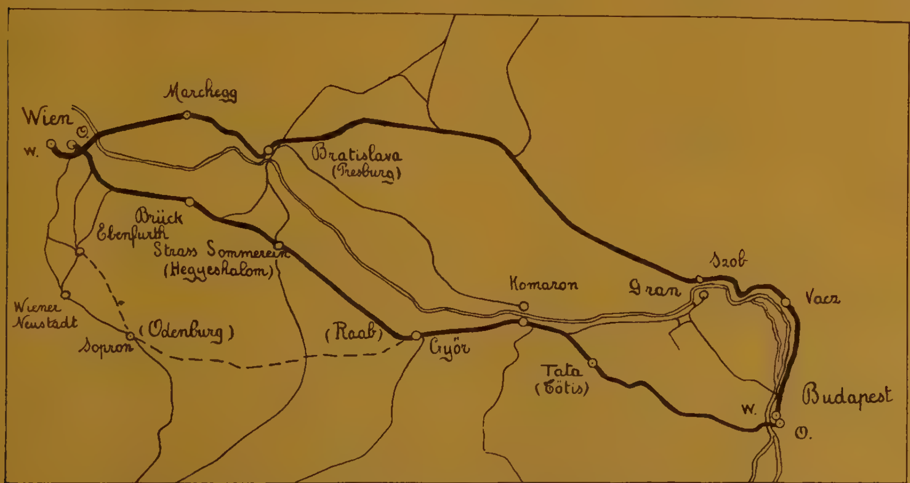


Fig. 199. — Competing lines by rail and river between Vienna and Budapest.
(The dotted line was temporarily used by the « Orient Express ».)

between the two capitals, which obviously is much slower; moreover, it takes nearly twice as long to travel up the river as down it.

XXXV-3. — **The International Sleeping Car Company's Hungarian services.** — The star-like formation of the Hungarian railway system has affected the Com-

(1) As far as Hegyeshalom.
(2) As far as Marchegg.
(3) Mention may be made of the fact that the distance from Vienna to Budapest, via Odenburg and Györ, is 318 km. (197.6 miles), of which 242 (150.4 miles) (from Odenburg) are in Hungary. This route is sometimes used by through trains between the two capitals.

pany's services, 38 in number, which all start from Budapest (fig. 200):

	In each direction.
Sleeping-Car Co. trains .	3
Sleeping-car services . .	16
Restaurant-car services .	19
Pullman-car services . .	0

Before the war, there were 14 sleeping-, 30 restaurant-car services and 4 « de luxe » trains serving Budapest, besides 4 radiating restaurant-car services that did not run as far as the capital.

Hungary was, we think, the first country to run buffet cars, which the Company operated on behalf of the *Hungarian State* between Budapest and Brück, Zagreb, Fiume, Arad, Zsolna (Sillein), Miskolc, Csap and Kassa.

TABLE 195.

INTERNATIONAL SLEEPING-CAR CO.'S HUNGARIAN SERVICES.

Obsolete trains are shown *in italics*.

Origin.	HUNGARIAN SECTION OF RUN.	Distance		Time of departure.	Time spent.	Speed		—
		Km.	Miles.			Km./h.	Miles/h.	
Calais.	Szob-Budapest Nyugati-Lököshaza	288	179.0	8.37 p. m.	5.12	55.4	34.4	Orient Express.
	Szob-Budapest	63	39.1	9.13 a. m.	0.56	67.4	41.9	
	Budapest-Cegled	73	45.4	10.05 p. m.	1.07	65.4	40.6	
	Szajol-Bekescsaba . . .	85	52.8	11.57 p. m.	1.18	66.7	41.4	
	Budapest Nyugati-Kelebia.	174	108.1	11.48 p. m.	3.16	55.1	34.2	
Paris Est.	Hegyeshalom-Bud. Keleti-Kelebia	351	218.1	8.25 p m.	6.37	52.9	32.9	Arlberg Orient Exp. (Athens).
	Hegyeshalom-Györ . . .	46	28.6	R 9.50 a. m.	0.36	76.7	47.7	Do.
	Györ-Budapest Kelenföld .	130	80.8	R 8.05 a. m.	1.44	75.0	46.6	Do.
	Bud. Ferenov-Kunszentmiklos	53	32.9	R 4.31 a. m.	0.52	60.1	37.3	Do.
	Bud. Keleti-Kelebia . . .	163	101.3	12.01 a. m.	2.05	78.2	48.6	Do.
Do.	Hegyeshalom - Bud. Keleti - Biharkeresztes	229	142.3	8.25 p. m.	7.50	29.2	18.1	Arlberg Orient Exp. (Bucharest).
Berlin.	*Ersekujvar-Budapest Nyugati-Szabadka*	...	...	...	...	...	...	*Berlin Orient Exp.*
	Ersekujvar-Budapest Nyugati (1)	122	75.8	9.19 p. m.	1.41	72.5	45.1	*Do.*
	Bud. Nyugati-Kisköros .	116	72.1	11.20 p. m.	1.57	59.5	37.0	*Do.*
	Kisköros-Szabadka . . .	67	41.6	1.42 a. m.	1.02	64.8	40.3	*Do.*
Cannes.	Nagykanisza-Budapest Deli .	221	137.3	5.55 a. m.	4.50	45.7	28.4	Vienna—Tyrol—Riviera Express.

Until the war, the « Orient Express » was split up at Budapest, whence it ran to Constantinople by two different routes: one by Temesvar-Bucharest and Constantza, and the other by Kelebia, Szabadka and Belgrad.

It is often lost sight of that, in addition to the « Ostend-Vienna-Orient »

(1) The tariff distance is 118 km. (73.3 miles) instead of the actual 115.6 km. (71.8 miles).

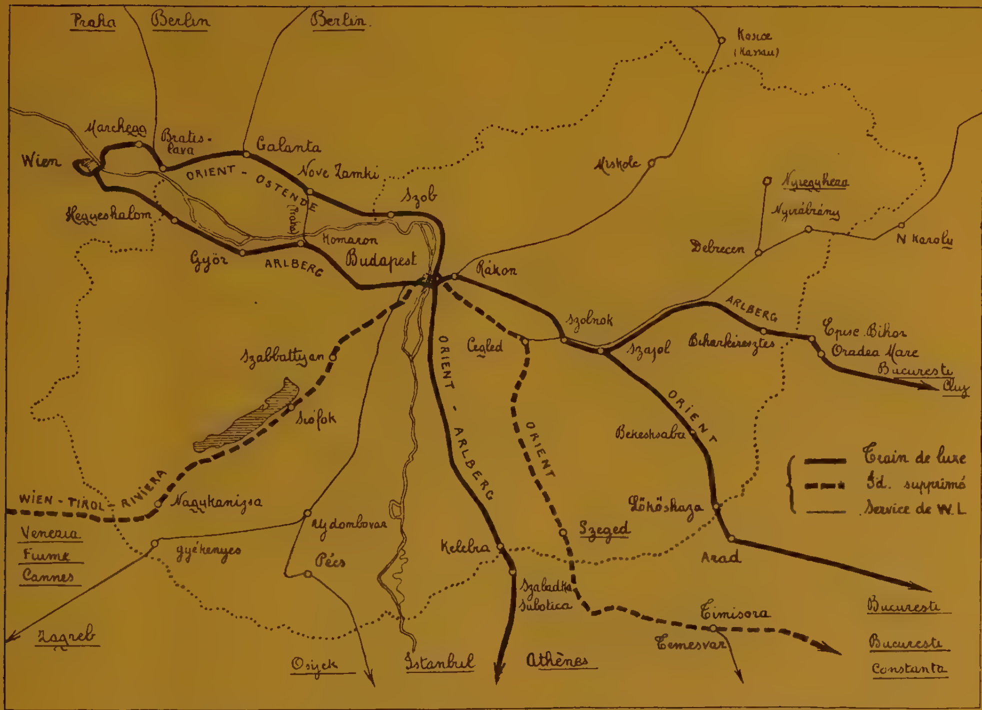


Fig. 200. — Hungarian routes of the *Sleeping-Car Company* trains.
Terminal points of sleeping-car services are underlined.

which still runs, there was, at the beginning of this century, a through train from Berlin to the East. This was the « Berlin-Budapest-Orient Express », the forerunner of the famous « Balkanzug » which only ran during the war. This train duplicated the old « Conventional » which will be dealt with hereafter.

Just as the new frontier obliged the *Hungarian Railways* to re-arrange some of their services, the *Sleeping-Car Co.* had to alter some of theirs. Thus the Bucharest section of the « Orient Express » was shifted from the Temesvar to the Arad line. South of the Danube the « Arlberg Express » now follows, between Vienna and Budapest, a line which formerly had no *Sleeping-Car Co.* trains, and from Budapest to Bucharest, a third radiating line which passes through Oradea-Mare.

The Company have given up their (Budapest) Ujdombovar - Gyekenyes - Zagreb services since 1932, when the *Danube-Save-Adriatic* Railway was taken over, and transferred them to the Nagykanizsa line.

Certain sleeping-car services no longer run beyond the frontier; these are the services from Budapest to :

Temesvar Bazias . . .	which now ends	at Szeged.
Temesvar Bucharest . .	do.	
Marmaro Szigett . . .	do.	at Wyrabrany.

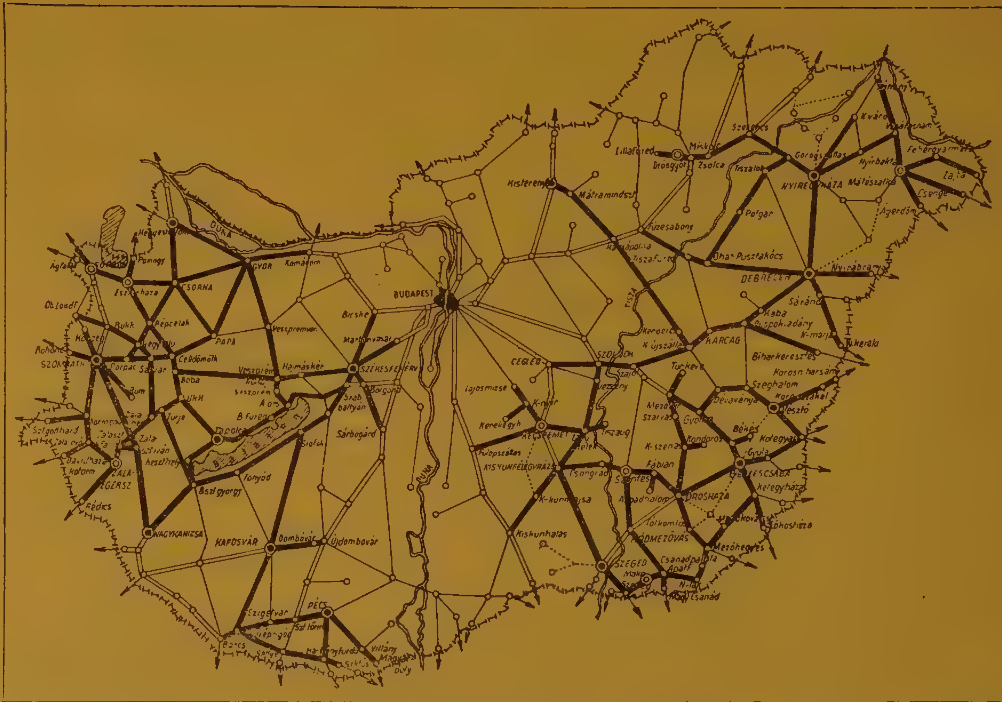


Fig. 201. — Hungarian lines served by Ganz-Jendrassik rail motor coaches.

A few services between Budapest and the following places have been discontinued or added :

Poprad and Tatra	now discontinued.
Galanta-Oderberg-Berlin . . .	do.
Pragersdorf-Merano	do.
Ujdombovar-Ossiek	added.

Finally, through sleeping-car services from Berlin and Prague to Athens and Bucharest have been introduced. They call at Budapest and are included in the « Simplon-Orient Express » on part of its route.

XXXV-4. — **Electric traction.** — Since the war, the southern Danube line has become the principal line of the country, especially as regards fast Austro-Hungarian communications; this led to the decision to electrify it throughout. On the Hungarian side, where the steepest gradients are 1 in 129 only, the 63-km. (39.1 miles) Budapest-Komaron section has been electrically operated for some time, and the whole of the 188 km. (116.8 miles) of the Hungarian section (as far as Hegyeshalom) has been electrified recently. Fast trains are hauled, with the same timings, either by electric or steam locomotives, but the latter are to be transferred elsewhere.

XXXV-5. — **Rail motor cars.** — The

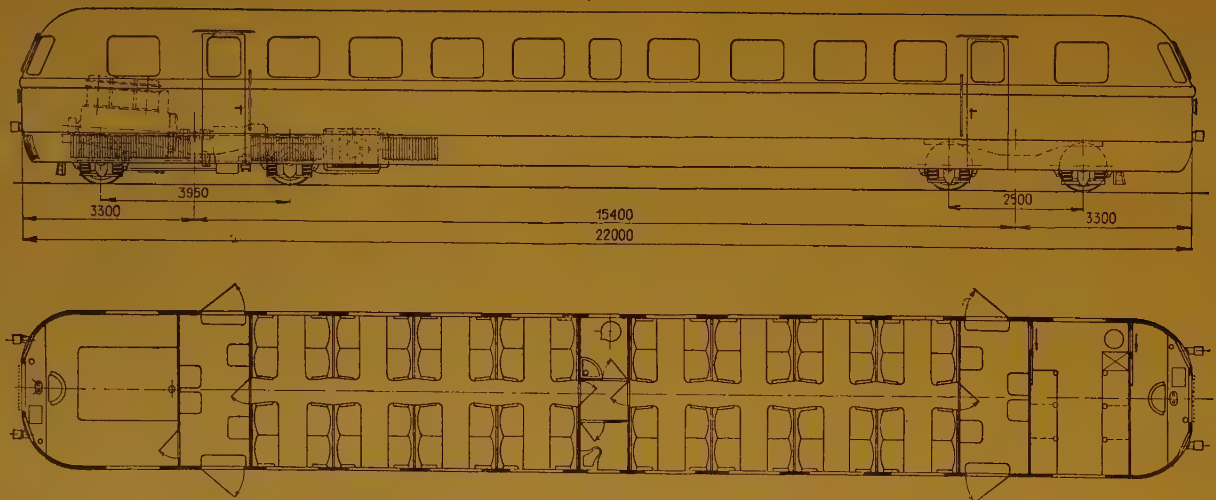


Fig. 202. — Ganz-Jendrassik type VI diesel railcar (220 H.P. at 1 200 r. p. m.).

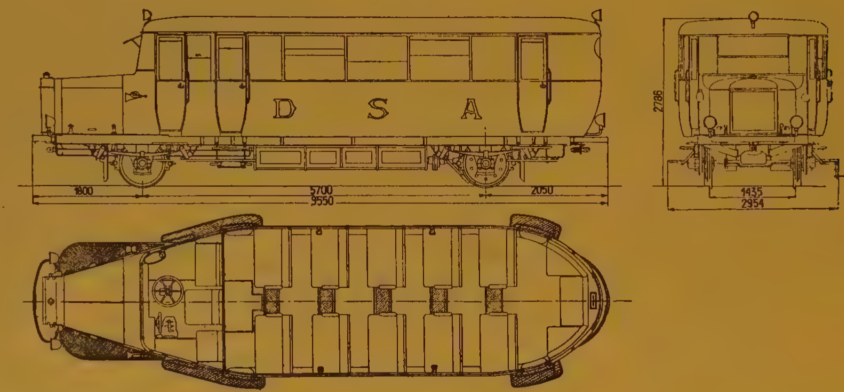


Fig. 203. — *Danube-Save-Adriatic Raiway* railcar, with 100-H.P. Ganz-Jendrassik diesel engine.

Table 196.

LEADING DIMENSIONS OF THE HUNGARIAN RAILCARS

built by the Ganz Works, Budapest.

Number of wheels	6	4	8	4	8	4	8
Wheel diameter	0.92 m. (3′ 1/4″)	...	...	...	...	...	...
Wheel base	6.20 m. (20′ 4 1/8″)	6.20 m. (20′ 4 1/8″)	4.00 m. (13′ 1 1/2″)	7.00 m. (22′ 11 5/8″)	2.50 m. (8′ 2 1/2″)	6.70 m. (21′ 11 13/16″)	3.95 m. (12′ 11 1/2″)
Distance between bogie centres	...	...	3.50 m. (11′ 5 13/16″)	...	2.80 m. (9′ 2 15/64″)	...	2.50 m. (8′ 2 1/2″)
	...	...	...	...	11.50 m. (37′ 8 3/4″)	...	15.40 m. (50′ 6 5/16″)
Overall length	12.02 m. (39′ 4 33/64″)	12.02 m. (39′ 4 33/64″)	23.23 m. (76′ 2 19/32″)	12.70 m. (41′ 8″)	18.40 m. (60′ 4 7/16″)	10.30 m. (33′ 9 33/64″)	22.00 m. (72′ 2 1/8″)
Body length	10.79 m. (35′ 4 13/16″)	10.79 m. (35′ 4 13/16″)	22.00 m. (72′ 2 1/8″)	11.47 m. (37′ 7 19/32″)	17.10 m. (56′ 1 15/64″)	10.30 m. (33′ 9 33/64″)	22.00 m. (72′ 2 1/8″)
Body width	3.08 m. (9′ 10 7/16″)	3.08 m. (9′ 10 7/16″)	2.93 m. (9′ 7 11/32″)	3.08 m. (9′ 10 7/16″)	2.98 m. (9′ 9 5/16″)	3.10 m. (10′ 2″)	2.985 m. (9′ 9 33/64″)
Outside height from rail level	4.08 m. (13′ 4 5/8″)	4.08 m. (13′ 4 5/8″)	3.60 m. (11′ 9 25/32″)	3.56 m. (11′ 8 5/32″)	4.09 m. (13′ 5″)	2.933 m. (9′ 7 15/32″)	3.30 m. (10′ 9 15/16″)
Horse power	120	110	400/600	110	150	95	200
Number of places, seated	15	15	64	43	20	36	64
Number of places, standing	31-L.c.	31-L.c.	...	...	52 L.c.	Lug. van	8 tip-up.
Weight, empty M. t.	19.8	18.8	...	19.6	...	9.0	...
(Engl. t.)	(19.5)	(18.5)		(19.3)		(8.85)	
Do. in working order M. t.	20.2	19.3	42.0	20.0	35.0		27.0
(Engl. t.)	(19.2)	(19.0)	(41.3)	(19.7)	(34.4)		(26.6)
Do. fully loaded M. t.	24.2	23.0	48.0	24.0	42.0	12.0	35.0
(Engl. t.)	(23.8)	(22.6)	(47.2)	(23.6)	(41.3)	(11.8)	(34.4)
Trailers	3 × 18 t. (17.7 E. t.)	3 × 18 t. (17.7 E. t.)	3 × 19 t. (18.7 E. t.) or 2 × 45 t. (44.3 E. t.)	yes.	yes.	no.	no.
Maximum speed	60 km./h. (37.3 m. p. h.)	55 km./h. (34.2 m. p. h.)	90 km./h. (55.9 m. p. h.)	75 km./h. (46.6 m. p. h.)	120 km./h. (74.6 m. p. h.)	90 km./h. (55.9 m. p. h.)	115 km./h. (71.5 m. p. h.)

Györ-Sopron-Ebenfurt Railway was among the first to adopt such vehicles and they were soon used on an extensive scale in the whole of Hungary, the *State Rys.'* thirty or so petrol railcars being converted since into diesels (fig. 201).

The *State* now owns some 118 railcars (and 135 trailers), the *Györ-Sopron-Ebenfurt*, 11, and the *Szeged-Czanod*, 10 (1). They are all 4-, 6- or 8-wheeled vehicles which can haul 1, 2 or 3 trailers.

Although the Hegyeshalom line has been electrified, fast railcars have been introduced recently; they cover the distance between Budapest and Vienna in about 3 hours, the speed thus working out at 91.4 km. (56.8 miles) an hour, with one intermediate stop at Hegyeshalom.

Even 0.76-m. (2 ft. 5 7/8 in.) gauge lines, such as the Miskolc-Lillafüred railway, having 1 in 26 gradients, are operated by diesel railcars.

Figure 203 featuring one of the early *Danube-Save-Adriatic* railcars shows the rapid progress made in a very few years. Among other interesting constructional details, may be mentioned the interior arrangement of certain railcars which provide five transverse seats, besides a corridor, for a total width of only 3.08 m. (10 ft. 1 9/32 in.) (fig. 204).

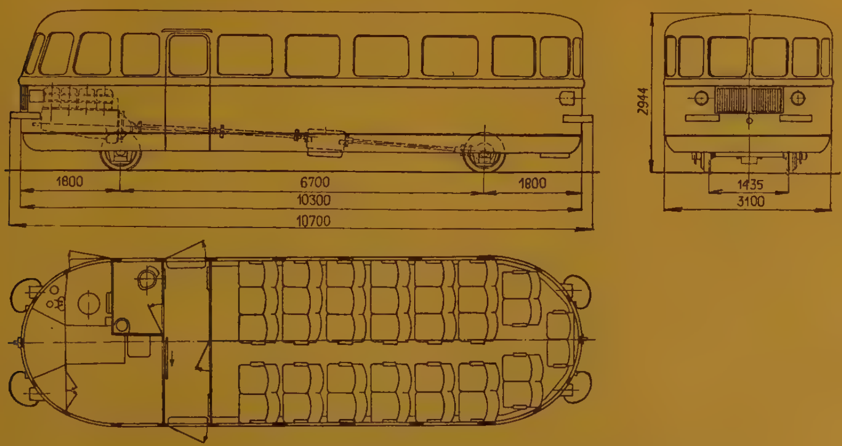


Fig. 204. — Ganz-Jendrassik, type VIII, 96-H.P. diesel railcar.

The specially built trailers weigh 13.5 t. (13.3 Engl. tons) empty, and 18 t. (17.7 Engl. tons) with 56 passengers.

XXXV-6. — **The train speeds** (fig. 206). — The Hungarian timings are drawn up on the following basis :

Fast trains	Running speed :	75 to 90 km./h. (46.6 to 55.9 m. p. h.).
Local trains	Do.	50 to 70 km./h. (31.0 to 43.5 m. p. h.).
Goods trains	Do.	30 to 50 km./h. (18.6 to 31.0 m. p. h.).

(1) At that time, the *State* owned 1943 steam locomotives, the Györ-Sopron-Ebenfurt 32, and the *Szeged-Czanod* 12.

Now, the general economic position has compelled Hungary to use its fast trains for a dual purpose: international services and home services, which precludes their having any long non-stop runs.

The basic speeds on high-speed lines are as follows:

75 (46.6), then 85 km. (52.8 miles) per hour	Budapest Keleti to Hegyeshalom.
— — 90 km. (55.9 miles) per hour	Do. Nyugati to Szob.
— — 80 km. (49.7 miles) per hour	Do. do. -Szeged.
80 (49.7), then 70 km. (43.5 miles) per hour	Do. do. -Miskolc.
— — 85 km. (52.8 miles) per hour	Do. Deli to Nagykanisza.

TABLE 197.

CALORIFIC VALUE OF HUNGARIAN FUEL, AND THAT OF SOME OF THE NEIGHBOURING COUNTRIES (1).

ORIGIN.		B. T. U./lb. Maximum.	B. T. U./lb. Minimum.	Humidity. °/°	Tar. °/°	Ashes.
	Hungary.					
Coal.	Salgo-Tarjan	13 125	12 574	11.08	9.1	6.2
	Pécs	12 884	12 355	10.89	7.4	15.7
Lignite.	Totis	10 850	10 215	8.9	20.4	6.6
	Borsod	7 902	7 246	6.4	18.3	5.9
	Mor	9 439	8 740	7.7	18.8	8.9
	Sopron	9 295	8 692	7.7	12.2	7.4
	Salgo	6 282	5 500	4.9	13.8	19.1
	Jugoslavia.					
Lignite.	Ivanec	6 217	6 843	4.9	7.3	12.3
	Prevalje	8 437	7 826	6.9	16.3	12.8
	Trbovlje	8 940	8 212	7.3	14.9	4.5
	Lasko	9 536	8 915	7.9	19.4	3.4
	Rumania.					
Coal.	Noua	14 567	14 194	12.5	...	6.3
	Austria.					
Lignite.	Ratten	6 323	5 653	5.0	11.8	6.6
	Statzendorf	9 369	8 733	7.7	12.9	10.2
	Czechoslovakia.					
Coal.	Ostrau	13 798	13 293	11.7	9.8	5.5
	Karwin	14 486	13 978	12.3	14.9	3.3
	Orlau-Lazy	14 185	13 654	12.0	15.8	2.8
	Kladno	12 250	11 718	10.3	13.5	4.2
	Mayrou Schacht	11 858	11 341	10.0	13.1	7.0
	Pilzen	12 657	12 124	10.7	13.0	7.3
Lignite.	Brux-Teplitz	10 998	10 359	9.1	26.0	2.3
	Dux-Teplitz	9 090	8 377	7.4	22.2	2.8
	Lalkenau	8 667	7 882	7.0	26.0	3.1

(1) According to Frans Schwackhöfer.

TABLE 198.

NOTEWORTHY HUNGARIAN TRAIN SPEEDS AND RUNS (fig. 206).

RUN.		Distance.		Time of departure.	Time spent.	Speed.		Number of stops.	—
om apest.	DESTINATION.	Km.	Miles.			Km./h.	Miles/h.		
leti.	Miskolc (Satoralja Ujhely)	185	115.0	6.50 a. m.	3.03	60.7	37.7	3	
	Budapest-Hatvan	69	42.9	6.50 a. m.	1.06	62.7	39.0	...	
gati.	Cegléd-Szolnoc-Debrecen	222	138.0	2.00 p. m.	3.52	55.7	34.6	...	
	Budapest-Cegléd	73	45.4	10.05 p. m.	1.07	65.4	40.6	...	Orient Express.
	Do. -Szolnoc	101	62.8	10.05 p. m.	1.33	65.2	40.5	1	
gati.	Szolnok-Lököshaza (Arad)	225	139.8	10.05 p. m.	3.44	60.2	37.4	2	Orient Express.
	Szajol-Bekescsaba	75	46.6	11.57 p. m.	1.18	57.7	35.9	...	Do.
	Bekescsaba-Lököshaza	29	18.0	1.21 a. m.	0.28	62.1	38.6	...	Do.
gati.	Szeged	190	118.1	7.50 a. m.	3.19	57.3	35.6	5	
leti.	Budapest-Ujszasz-Szolnok	100	62.1	12.01 a. m.	1.42	58.8	36.5	2	
	Do. -Nagykator	53	32.9	9.00 a. m.	0.58	54.9	34.1	..	
	(Budapest) Rakos-Szolnok	92	57.2	12.21 a. m.	1.22	67.3	41.8	...	Orient Express.
leti.	Kelebia (Subotica-Belgrad)	163	101.3	12.01 a. m.	3.05	52.9	32.9	...	Do.
	Soroksar-Kunszentmiklos	45	28.0	9.12 a. m.	0.40	67.0	41.6	...	
leti.	Ujdombovar-Pecs (1)	238	147.9	...	...	...	...	...	
leti.	Ujdombovar-Gyekenyes (1)	272	169.0	8.30 a. m.	5.34	50.3	31.3	...	Fiume, etc.
	Budap. Kelenföld-Pusztaszabolcs	49	30.4	8.48 a. m.	0.36	81.7	50.8	...	Do.
eli.	Kotor	237	147.3	R 5.13 a. m.	4.32	52.3	32.5	...	
	Bud. Kelenföld - Szekesfehervar	63	39.1	R 6.53 a. m.	0.51	74.1	46.0	...	
	Szekesfehervar-Siófok	48	29.8	R 6.13 a. m.	0.40	72.0	44.7	...	
leti.	Aisöra-Tapolca (1)	200	124.3	6.00 a. m.	4.48	41.7	25.9	...	
leti.	Györ-Papa-Szengotthard (Graz) (1)	313	194.5	...	...	...	...	...	
leti.	Györ-Hegyeshalom (1)	188	116.8	7.50 a. m.	2.36	72.3	44.9	2	Arlberg Express.
	Budapest Keleti-B. Kelenföld (1)	12	7.5	7.50 a. m.	0.14	51.4	31.9	...	Do.
	Budapest Kelenföld-Komaron	92	57.2	R 11.16 a. m.	1.14	74.6	46.4	...	
	Budapest Kelenföld-Györ	130	80.8	8.05 a. m.	1.44	75.0	46.6	...	Do.
	Györ-Hegyeshalom	46	28.6	9 50 a. m.	0.36	76.7	47.7	...	Do.
gati.	Szob (Vienna)	63	39.1	7.15 a. m.	0.56	67.5	41.9	...	

(1) Actual mileage, not tariff distance.

TABLE 199.

FASTEST HUNGARIAN TRAINS, LONGEST RUNS AND SERVICES TO AND FROM WATERING PLACES.

RUN.	Distance Km.	Distance Miles.	Time of departure. (1)	Time spent.	Speed. Km./h.	Speed. Miles/h.	—
Fastest runs.							
Budap. Kelenföld-Pusztaszabolcs .	49	30.4	8.48 a. m.	0.36	81.7	50.8	Towards Fiume.
(Budapest) Györ-Hegyeshalom .	46	28.6	9.50 a. m.	0.36	76.7	47.7	Arlberg Express.
Budapest Kelenföld-Györ . . .	130	80.8	8.05 a. m.	1.44	75.0	46.6	Electric.
Székesfehervar-Siófok	48	29.8	R 6.13 a. m.	0.40	72.0	44.7	Balaton Exp. (1).
Budapest Deli-Szabadbattyan . .	100	62.1	R 8.25 a. m.	1.20	75.0	46.6	
Long non-stop runs.							
Budapest Kelenföld-Györ . . .	130	80.8	8.05 a. m.	1.44	75.0	46.6	Electric.
(Budapest) Rakos-Szolnok . . .	92	57.2	12.21 a. m.	1.22	67.3	41.8	Steam.
Budapest Déli-Szabadbattyan . .	100	62.1	R 8.25 a. m.	1.20	75.0	46.6	
Budapest Nyugati-Cegléd . . .	73	45.4	10.05 p. m.	1.07	65.4	40.6	
Szajol-Bekescsaba	85	52.8	10.57 p. m.	1.18	66.7	41.4	Orient Express.
Railcar services.							
Budapest Keleti-Vienna Ost. . .	271	168.4	7.12 a. m.	2.58	91.3	56.7	1 stop. (since end 1934).
Budapest-Hegyeshalom . . .	188	116.8	R 9.09 p. m.	2.04	91.0	56.5	Do.
Hegyeshalom-Vienna Ost. . .	83	51.6	9.19 a. m.	0.51	97.4	60.5	Do.
Miskolc S. Anna-Lillafüred . . .	12	7.5	10.39 a. m.	0.45	16.0	9.9	6 st. — 2′ 5 7/8″ gauge.
Györ-Sopron (Ebenfurt) (2) . .	86	53.4	10.21 a. m.	1.23	62.2	38.7	*G.S.E.* (5 stops).
Györ-Enese (2)	19	11.8	10.21 a. m.	0.16	71.2	44.2	Do.
Electric services.							
(Budapest Keleti) Budapest-Kelenföld-Komaron	92	57.2	R 11.16 a. m.	1.14	74.6	46.4	
Budapest Kelenföld-Györ . .	130	80.8	8.05 a. m.	1.44	75.0	46.6	Arlberg-Orient.
Györ-Hegyeshalom	46	28.6	9.50 a. m.	0.36	76.7	47.7	Do.
Services to watering places.							
Budapest Deli (Sud)-Fonyód . .	157	97.6	R 5.30 a. m.	2.13	70.8	44.0	Balaton Express (8 stops).
Budapest Deli-Siófok	115	71.5	R 6.13 a. m.	1.40	69.0	42.9	Balaton Express (3 stops).
Albertfalva - Budafok Székesfehervar	59	36.7	R 6.53 a. m.	0.51	69.4	43.1	Do.
Székesfehervar-Siófok	48	29.8	R 6.13 a. m.	0.40	72.0	44.7	Do.
Siófok-Balatonföldvár	15	9.3	R 5.56 a. m.	0.16	75.0	46.6	Do.
Balatonföldvár-Balatonszemes .	9	5.6	2.50 p. m.	0.07	77.1	47.9	Do.
Balatonboglar-Fonyód	8	5.0	R 5.30 a. m.	0.07	80.0	49.7	Do.

(1) The « Balaton Express » is run by the *Hungarian Railways*, and not by the *Sleeping-Car Co.*

(2) Actual distance.

Trains are still heavy. During the years 1928 and 1929, on the Budapest-Vienna line, their weight reached 720 to 1 000 t. (689 to 984 Engl. tons), not including the 130-t. (128 Engl. tons) locomotive. On rising gradients, the speed was 75 km. (46.6 miles) per hour; on falling gradients, 90 km. (55.9 miles).

The tenders of the heavy locomotives have a water capacity of 24 m³ (6 340 Br. gallons) and take as much as 21 m³ (27.4 cubic yards) of coal.

Hungarian lignite is of fairly good quality and yields up to 5 000 calories (9 000 B. T. U./lb.) i.e. more than that found in neighbouring countries, where it is also used as locomotive fuel. On the other hand, Hungarian pit coal is of relatively lower quality.

The Hungarian locomotives, like the Bavarian ones, have a very high boiler centre line. It is 3 300 m. (10 ft. 10 in.) above rail level in the case of the *Consolidation* class 122 locomotives (1), which is one of the highest anywhere.

The big *Mallet* locomotives have been handed over to the neighbouring countries.

Watering place services. — Even be-

Fig. 205. — Lake Balaton.
Legend: See speed map, fig. 206.

(1) Boiler centre line :

Class 118 . . 3.150 m. (10 ft. 4 in.).
Do. 101 . . 3.020 m. (9 ft. 11 in.).
Class 117 . . 2.900 m. (9 ft. 6 3/16 in.).

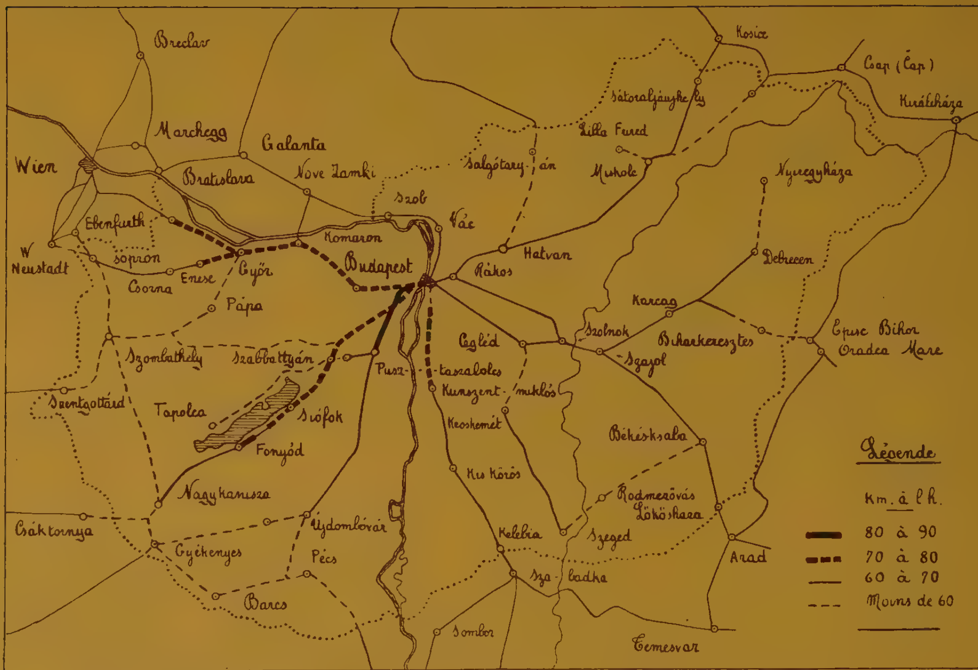


Fig. 206. — Map of Hungarian lines showing maximum overall speeds over each.

fore the war, Lake Balaton, one of the largest in Europe [1], was a well-known holiday resort, and since then these watering places have been much improved, particularly on the northern shore (fig. 205).

In addition to the Italian services along the eastern shore, a « Balaton Express » carrying residents to the capital in the morning and back in the afternoon has been introduced. Between Fonyód and Siófok (42 km. = 26.1 miles) this train stops four times, after which it only serves one other place before arriving at Budapest. On the section including these stops an average speed of as much as 80 km. (49.7 miles) an hour has to be maintained between them, which necessitates very quick acceleration.

The speed of the boats on the lake is 15 km. (9.3 miles) an hour.

XXXV-7. — **Conclusions.** — The average speed of the express trains is not very high. Table 200 summarises the country's position as regards speed.

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(1) Lake Balaton is 85 km. (52.8 miles) long, and its maximum width is 13 km. (8.1 miles) in the northern part, which is separated from the other (maximum width 11 km. = 6.8 miles) by a channel 1 500 m. (0.93 mile) wide only. Its area is 598 km² (230 sq. miles) and its average depth 10 feet with a maximum of 38 feet.

Table 200.

MILEAGE AND PROPORTION OF HUNGARIAN LINES RUN OVER AT VARIOUS OVERALL SPEEDS.

Miles.	Speed.		Kilometres.	Percentage.
	Miles per hour.	Kilometres per hour.		
30	50 to 55.9	80 to 89.9	49	0.3
239	44 to 49.9	70 to 79.9	385 (1)	5
773	38 to 43.9	60 to 69.9	1 243 (2)	15
4 074	Under 38	Under 60	6 556 (3)	79.7
5 116	TOTAL		8 233	100

(1) 19 km. (11.8 miles) of which belong to the *G. S. E.*
(2) 69 km. (42.9 miles) of which belong to the *G. S. E.*
(3) 335 km. (208.1 miles) of which belong to the *G. S. E.*, the *M. P.* and the *S. C.*

(To be continued.)

[656. (.4)]

A comparative study of motor transport regulation,

by Vladimir IBL,

Engineer, Manager of the Road Services, Czechoslovak State Railways.

FOREWORD.

The road services of the Czechoslovak State, whose omnibus services alone cover approximately 8 000 km. (5 000 miles), are operated by a subsidiary Company of the State Railways. The supreme control of the State Railways is in the hands of the Ministry of Railways, which is also responsible for certain private lines and tramways of a total length of approximately 800 km. (500 miles).

According to the present road motor transport legislation in force in Czechoslovakia, the State Railways take part in the administrative proceedings in connection with the introduction of new road services by private firms and the sanction of changes in existing services. The Ministry of Railways collaborates in the drafting of legislative measures intended to regulate motor transport. The above mentioned duties fall upon the Headquarters Office of State Road Services, which forms part of the Ministry of Railways. As head of this department, we have to follow carefully the regulations on motor transport in foreign countries, to keep ourselves continually informed as to their evolution, and to analyse them, according to a definite plan, from various angles.

Moreover, as we are responsible for the documentation of the First Regional Railway Group of the International Railway Union (GREM) including the Polish, Czechoslovak, Jugoslav, and Bulgarian State Railways, we thought this service might profit by the information thus collected, as well as by the results to be deduced from the comparative analyses of the data collected.

Originally the analysis had to be limited, apart from countries belonging to the GREM (Poland, Rumania, Czechoslovakia, and Jugoslavia), to the following countries : Germany, Austria, Belgium and Hungary. But since the inception of the work (September 1933), regulation of motor transport in France and Switzerland has made definite progress, so that the investigation has been extended to these two countries. Later on, it was considered useful to include Italy as well.

As soon as we began our work, we thought that the *Bulletin of the International Railway Congress Association* was the suitable publication in which to publish in turn the more interesting portions of our investigations, and any additions or amendments to meet future changes.

* * *

In many countries, the public authorities and legislative bodies have ended by recognising that a rational co-ordination of transport would never be arrived at unless road motor transport were regulated.

Moreover, various international bodies have regularly followed the evolution of motor transport, especially from the point of view of competition against the railway, and kept records of the attempts made to achieve rational co-ordination.

In this form the studies in question have already proved their utility, first of all for the Railway Administrations by making useful comparisons possible and giving rise to new ideas; however, they do not allow of a thorough investigation into the different aspects of the Rail-Road problem in view of the unavoidably heterogenous character of the information collected in different countries, even if the subject matter of such information is more or less defined. This makes it necessary to get to the sources themselves, and to consult one by one the regulations in force in each country. Sometimes such sources are not sufficiently and completely known or mentioned in the studies under consideration. In any case when referring to them, there is often the difficulty of understanding the language of the country whose regulations are under consideration.

Thanks to certain favourable circumstances and the courteous collaboration of his colleagues in many European countries, the Author has been able to collect more or less complete information about these countries, information which he was led to study under the various aspects of the « Rail-Road » problem. He feels that he will not merely be duplicating the publications mentioned above, if he puts at the disposal of the readers of the *Bulletin* the most interesting results of his work with the object that the Railway Administrations should have the same views on the solutions of this problem, which closely concerns them all.

Our chief desire is to show in a series of articles (divided up in *chapters)* how, in the public interest and in order to meet the needs of a reasonable transport policy, the different regulations in force are intended to introduce order into commercial motor transport work, and ultimately to bring private goods road transport within the scope of such a policy.

After examination, we have decided not to examine the measures taken by the railways in connection with their operation and rates in order to meet motor competition, nor their endeavours to achieve, by means of agreements, a division of the traffic between rail and road, as we feel that this side of the question has been sufficiently dealt with in other publications.

Our study will first of all deal with *special legislation* for the regulation of motor transport; but when the various provisions affecting such transport are scattered among various acts, all such provisions will be taken into account, and the acts concerned quoted.

Each of the different chapters of our study deals with one particular requirement of the regulations and is preceded by a list of the legislative acts making up each country's regulations, to which we shall be constantly referring.

List of the legislative or administrative provisions regulating motor transport in the various European countries [1].

Germany.

1. *The concession code for commercial road motor passenger services* was introduced by the new law of the 4th December 1934 on tramways, road motor vehicles and horse-drawn vehicles working public passenger services whether local or interurban (Gesetz über die Beförderung von Personen zu Lande). In the case of *concessions* for *professional* road motor *goods transport,* the provisions of chapter V of the *Ordinance of the 6th October 1931* (Überlandverkehr mit Kraftfahrzeugen) [2] which regulates such transport carried out for reward within a radius exceeding 50 km. (31 miles) remain in force.

2. A *special law of the 27th June 1933* gives the State Railways the right to build and operate a *motor road system* (Gesetz über die Errichtung eines Unternehmens « Reichsautobahnen »).

The first *ordinance for the application of this law* (Erste Verordnung zur Durchführung des Gesetzes über die Errichtung eines Unternemhmens « Reichsautobahnen ») is dated the 7th August 1933.

3. The *safety of road motor* traffic is regulated by the *law of the 3rd May 1909* (Reichsgesetz über den Verkehr mit Kraftfahrzeugen), which was repeated in the law of the 21st July 1923 as well as by an ordinance of the 10th May 1932, *putting it into force* (Verordnung über Kraftfahrzeugverkerhr) and a *notice* (Bekanntmachung über Kraftfahrzeugverkehr) dated the 12th May 1932 published in the « Reichsministerialblatt », on page 267.

In addition there are a great many laws and ordinances, the chief being the *highway codes* for the different provinces (Stassenverkehrsordnungen) which contain many regulations on the working of motor vehicles, such as vehicle lights, notice plates, training of drivers, carrying explosives, etc.

All these regulations were combined in the *highway code for the whole of the Reich* (Reichs-Strassen-Verkehrsordnung nebst Einführungs-Verordnung), published by the Ministry of Communications on the 28th May 1934 (Reichsgesetzblatt, Teil 1, No. 59, 30th May 1934). This legislation came into force on the 1st October 1934.

4. *Taxation* of motor vehicles is regulated by the law of the *16th March 1931 on motor vehicle taxes* (Kraftfahrzeugsteuergesetz).

With the object of reducing unemployment, *the law of the 10th April 1933* exempted automobiles (other than motor char-a-bancs), motor cars and motor cycles, put into circulation after the 31st March 1933, from the tax on automobiles.

The *ordinance* enforcing the law of the 16th March 1931 (Ausfuhrungsbestimmungen zum Kraftfahrzeugsteuergesetz) was published on the 21st March 1932.

As regards fiscal charges on motor transport, §§ 13 and 41 of the law of the 27th April 1926 known as the « Finanzaugleichsgesetz » and repeated in the law

(1) Brought up to date to the 31st December 1934.

(2) Until the law of the 4th December 1934 came into force, this decree applied equally to interurban road motor passenger services over a fixed route at fixed hours.

of the 16th March 1931, are also to be taken into account.

5. The second chapter of the *law of the 3rd May 1909*, amended by the *ordinance of the 6th February 1934* (Verordnung zur Änderung der Haftpflichthöchstsummen im Kraftfahrzeug- und im Luftverkehr) lays down the responsibilities imposed on road motor operators.

Austria.

1. The essential provisions governing public town to town road services along specified routes to booked times are to be found in a chapter of *law No. 294 of the 3rd October 1931*, intended to place the public finances on a sound basis (Budgetsanierungsgesetz). Chapter VI of this law (Bestimmungen über Kraftfahrlinien) lays down the *rules for concessions* in connection with the above mentioned services.

Two orders were issued in pursuance of the clauses of chapter VI of this law :

The first, *No. 463, dated the 18th December 1931;*

The second, *No. 334, dated the 25th November 1932;*

1 and 2 — Durchführungsverordnung zum Kraftfahrliniengesetz.

2. Paragraph 13 of chapter VI of the law merely deals with the *approval and publication of the timetables and rates* in a general way. The details of the procedure are laid down by the *decree of the Minister of Commerce and Industry*, dated the 4th February 1931 (Verordnung über die Genehmigung und Veröffentlichung der Fahrpläne und Tarife der Unternehmungen für den periodischen Personentransport mit Kraftwagen).

3. In the case of public *goods* transport, not covered by the regulations quoted above, the *concession conditions* are regulated by *order No. 109 of the 31st March 1931* (Verordnung über die Bindung des Gewerbes der Beförderung von Lasten mit Kraftfahrzeugen an eine Konzession).

4. The observation of *minimum rates by public goods road transport undertakings* is the subject of *decree No. 253 of the 9th June 1933* (Lastkraftwagenverkehrsverordnung). This decree was to remain in force until the 30th June 1934; it was amended by *decrees No. 553 of the 7th December 1933* and *No. 151 of the 23rd February 1934.*

Law No. 85 of the 15th June 1934 extended the time decree No. 253 was to be in force to the 31st December 1934.

5. As regards the *safety of motor traffic*, mention must first of all be made of the *general road police regulations* (Strassenpolizeivorschriften). *Special regulations* are laid down in *law No. 437 of the 20th December 1929* on *the use of road motor vehicles* (Kraftfahrgesetz), amended and completed by several decrees (No. 150 of the 28th May 1930; No. 243 of the 17th July 1930; No. 190 of the 10th July 1931; No. 282 of the 11th September 1931), and by law No. 594 of the 21st December 1933.

The application of the above mentioned law is the subject of *ordinance No. 138 of the 12th May 1930* (Kraftfahrverordnung), amended by several later ordinances (No. 261 of the 12th August 191; No. 54 of the 6th February 1932; No. 86 of the 17th March 1932; No. 44 of the 18th January 1934).

6. The *general responsibilities* of owners and operators of motor services are regulated by the *former Austrian law No. 162 of the 9th August 1908*, amended and completed by *order No. 221 of the*

28th October 1908, which somewhat lessened the obligations laid down in the previous law, and also by the *Federal law No. 300 of the 3rd May 1922* (Kraftfahrzeug-Hafpflichtgesetz).

7. The *fiscal charges on motor traffic* are laid down by law No. 45 of the 28th *January 1931* dealing with the *taxes on petrol and on motor vehicles* (Benzinsteuer- und Kraftwagenabgabegesetz).

The *application* of this law is the subject of *order No. 115 of the 17th April 1931*, amended as regards the tax on motor vehicles, by order No. 124 of the 6th July 1934.

The clauses of the law and decree mentioned above were modified and extended by the regulations contained in *law No. 294 of the 3rd October 1931* (Budgetsanierungsgesetz). Chapter III, paragraph II, of this law provides for an *increase in the petrol tax*, and chapter IV introduces a *new tax on public road transport* (Kraftwagenverkehrssteuer).

The provisions of this law relating to the *tax on road motor transport* were made the subject of *order No. 324 of the 21st October 1934*.

Belgium.

1. The regulations are mainly based on the *law of the 21st March 1932 regulating public road motor buses and char-a-bancs*.

The *royal decree of the 17th May 1932 on the grant of authorisations for permanent road motor services, and on the investigations which should precede such authorisations*, is based upon clauses 4 and 6 of this law.

Clause 10 of the above decree authorises the Minister of Transport to draw up a *standard specification* on which to base the *special specification* for each particular case. The standard specification gives the general conditions upon which a licence is granted, as well as certain special conditions relating to the operation of the services, the staff concerned, the rates, and also the charges for road maintenance, imposed upon the operator of such services.

2. The law of the 1st August 1899, modified by the law of the 1st August 1924, constitutes the *highway code*.

Because of the development of road motor transport, the clauses of this law were modified and completed by the *royal decree of the 1st February 1934 giving the general regulations governing road motor transport*. These regulations were put into force by the ministerial decree of the 5th June 1934.

The above mentioned regulations contain, among other clauses, regulations limiting the loading gauge, the weight of vehicles and their loads, and lay down the width of tyres, use of brakes, etc.

3. *The operation of public motor omnibus and coach services* is the subject of *four special decrees*, all based on the law of the 21st March 1932 :

The first, *the royal decree of the 13th July 1932*, in accordance with clause 10 of the law of the 21st March 1932, designates the authorities whose duty it is to punish infringements of this law, as well as of the police regulations on the operation of public motor omnibus and coach services.

The second, *the royal decree of the 27th July 1932 dealing with the police regulations on the operation of public road motor omnibus and coach services*, specifies the duties of the operators and lays down the police regulations concerning passengers. (Application of clause 7 of the law of the 21st March 1932.)

The *next decree*, that of the *2nd Ja-*

nuary 1933, deals with the *inspection, approval, and supervision of vehicles used for public motor omnibus and coach services.* (Application of clauses 5, 11 and 12 of the law of the 21st March 1932.)

Finally, the fourth decree, the *royal decree of the 7th March 1933*, modifies certain clauses in the decree of the 2nd January 1933, on the *approval and supervision of public motor omnibus and coach services authorised by the provincial and borough authorities.*

To the above mentioned decrees must be added a *general regulation on public motor omnibus and coach services dated the 12th July 1933* which contains detailed provisions on the construction and fitting up of the vehicles, the obligation of the operator to insure his civil responsibility, the conditions under which the employees are passed and how they carry out their duties, the garaging of the vehicles, the responsibility of the operator in the case of abnormal wear of the roads due to his services, etc.

4. The fiscal charges are regulated by the following legislation :

Law of the 28th March 1932 on the annual tax on mechanical vehicles (including boats and canoes) *as well as their trailers.*

The provisions of this act were modified by two subsequent laws, those of the *31st December 1925* and *24th July 1927*. The *decree of the 29th December 1926* introduced supplements (decimes) to the taxes imposed by the *law of the 28th March 1923.*

The *royal decrees of the 22nd May 1923* and *30th October 1927* modified clause 12 of the law of the 28th March 1923 as regards the allocation to the provinces and boroughs of part of the revenue produced by the aforementioned taxes.

The new provisions of the code of stamp duties, introduced by the Royal decree of the 3rd March 1927, taxed contracts in connection with public transport by road of goods or passengers.

Two decrees were promulgated, on the 14th August 1933, in pursuance of the law of the 17th May 1933, giving the King the powers required to restore the finances and to balance the budget. The first imposed a substantial increase in the tax on private motor vehicles used for goods transport within a radius of more than 20 km. (12.4 miles) round the place of residence of the carrier. The other introduced a new and important tax on public goods transport services by road also carried out within a radius of more than 20 km., while abolishing in the case of such transport the tax imposed by the royal decree of the 3rd March 1927.

The dispositions of these two decrees were, however, modified and partly cancelled by the *law of the 30th December 1933*. The increase in the tax on motor vehicles introduced by the first of these decrees was considerably reduced, but extended on the other hand to lorries used exclusively for transport on behalf of third parties; however, these latter were exempt from the new tax on public road motor goods services and henceforth are only subject to the new tax imposed by the royal decree of the 3rd March 1927.

Finally mention must be made of the bill of law on better co-ordination of road and railway transport, presented to the Chamber of Deputies in March 1934, and which considers in particular the introduction of a system of authorisations for professional transport of goods by road.

France.

1. The essential provisions are contained in the *decree of the 19th April*

1934 on *co-ordination of road and railway transport.*

The application of clause 6 of the above mentioned law as regards the declaration required from non-subsidised operators of public road motor services is governed by a *decree dated the 19th April 1934.*

NOTE :

It is necessary to explain the legal position of public road transport firms in France before the law of the 19th April 1934 came into force. It is also necessary to define the classes of such services which are affected by this law.

The public transport services were grouped in four classes :

a) *Subsidised services* governed by the law of the 21st August 1923, which were subject to various regulations and had to comply with the specifications (mostly drawn up in accordance with the standard specifications of the 24th March 1924), and consequently were in a position very similar to that of the railways. In most cases the firm was subsidised by the Département with the assistance of the State.

b) *Postal services* (rural motor post service) worked either by the Post Office Administration or by contractors. Although primarily intended for the transport of mails and post parcels, these services can also be used for the transport of passengers and goods. Sometimes such services are also subsidised by the Départements or boroughs.

c) *Services operated by companies affiliated to the railway systems and by secondary railways themselves.*

The creation of the above mentioned companies required an authorisation from the public authorities (granted in 1928) who reserved the right to approve the conditions under which the services in question were operated and to pass the timetables, routes, and rates.

The concession holders of services of local railways were in many cases authorised by the authorities (Départements) to substitute road motor services for the train services. The intervention of the public authorities as regards the working of such services remains very marked.

d) *Uncontrolled services.*

The other services were completely free, i.e. the operators were free to do as they pleased as regards timetables, rates, choice of route, and could either always serve the same places or else follow the seasonal traffic currents without requiring any special authorisation. However, these services came under the police regulations like all the other services mentioned above.

The above mentioned law makes no explicit distinction between the four categories quoted above. It is obvious that subsidised services might continue to be operated — without infringing this law — on the basis of the respective contracts. But the experience acquired when the first regional agreements were made between road carriers and the railways shows that some of the former are quite prepared to come to terms and to submit to the conditions imposed by the authorities on the operation of road services under such agreements.

The rural postal services, on the contrary, are excluded from the above mentioned regulations.

On the other hand, the category of services operated by subsidiary companies of the main line railways is to be done away with in accordance with the wishes expressed by the public authorities. Moreover, when it makes its first agreement with a road firm, the railway formally undertakes to pay down its financial share in the company concerned.

The category of so-called free services

is naturally the main object of the regulations and these services will in the future be subject to the conditions laid down by the ministerial decrees.

After the agreements under consideration have been approved and the above mentioned decrees passed, no new services can be started without authorisation.

2. The highway code is the subject of the fundamental *law of the 30th May 1851*, completed by the *decree of the 31st December 1922* laying down the *general regulations on road traffic police*, modified subsequently by the decrees of the 12th September 1925, 21st August 1928, 5th October 1929, 25th September 1932 and 19th January 1933.

These regulations are completed by the *decree of the 30th June 1934 limiting the length and the total weight of vehicles running on the public highways.*

There are no special regulations as regards the responsibilities of the drivers of motor vehicles and their owners, and those of road motor operators.

3. The *fiscal charges* to which motor vehicles and public road motor services are subject are regulated by the second *decree codifying the legislation on indirect taxation*, of the 21st December 1926.

The *law of the 28th February 1933* completes the above decree, and imposes *new taxes* on motor vehicles and trailers, such as the tax on the total weight of the vehicle, fixed tax on trailers, tax on space taken up.

According to a note which appeared in the *Revue Générale des Chemins de fer* (September 1933, page 172) the *law of the 31st March 1933* includes an increase in the taxes paid by motor vehicles, and the *financial law of the 31st May 1933* has lightened the provisions of the law of the 31st March 1933.

Hungary.

1. The essential legal provisions are contained in *law No. XVI of 1930, regulating public motor transport undertakings* (A Kozhasználatu gépjáromü vállalatokról) which came into force on the 15th October 1931 [1].

The application of the above law was made the subject of a *decree issued by the Ministry of Commerce*, No. 57000, dated the 12th September 1931.

2. The *decree issued by the Home Office, No. 250 000 of the year 1929*, contains the provisions governing the road motor traffic and regulates traffic on the highways in a general manner.

(The decree quoted above is given in the work of Mr. Kontz, published in 1929 under the title : Automobil közlekedési rendészet).

3. The *contribution* of owners of motor vehicles as well as of public motor service undertakings to the cost of *construction, reconstruction and maintenance of the public highways* is regulated by *law No. VI of the year 1928* (A közuti Gépjáromüvek Közuti célokra való megadóztatósárol) as well as by a certain number of decrees issued by the Ministry of Finance (No. 15000/VII, 1928) and Commerce (No. 63000/1928, etc.). These decrees and the above law were quoted in a compendium entitled : « Gépjarmü-Typus-konnyv és Ujabb Rendeletek Gyüjteménye », published by the Hungarian Automobile Club.

In addition, the public services, by the

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[1] In accordance with this law, the Government handed over to the State Railways the exclusive concession for goods motor transport by road on condition that the concession should be worked by firms amalgamated into a Federation. This Federation was set up and the State Railways have entered with it into the agreement provided for.

terms of their concessions, are subject to a tax based on the horse-power of the motor vehicles employed. This regulation is based on *law No. 1 of the year 1890* on public highways and tolls.

The compendium mentioned above also contains certain decrees regulating the use and running of motor vehicles and the conditions to be fulfilled by their owners and drivers.

Italy.

1. The *regulation of concessions* for public road motor services, since 1904, have been the subject of several successive laws. Among these we must mention the third part of the *Regulations on railless mechanially-propelled vehicles* (Regolamento per i veicoli a trazione meccanica senza guida di rotaie), approved by the *royal decree No. 710 of the 29th July 1909*, which lays down the essential conditions for safety, and also deals with the formalities when applying for a concession, for all public services, both passenger and goods, with fixed routes and timings, as well as the procedure and obligations of the concession holder towards the authorities holding jurisdiction over him while the service is being operated under the concession.

2. A later *decree, No. 705 of the 7th May 1922*, clearly defines that taxi vehicles are not obliged to ask for a concession.

The same decree regulated the position of *provisional public services*.

3. The *royal decree No. 2386 of the 21st October 1923* contains provisions intended to guarantee the continuity and regularity of public services, as well as those on the right to a monopoly of lines worked under a concession, the contributions of the boroughs, the right of preference in the case of new concessions or for the renewal of old concessions. These regulations were completed by the *royal decree No. 2443 of the 9th December 1926*.

4. The *royal decree No. 922, of the 12th May 1927*, granting premiums to firms operating *long-distance tourist services* include special requirements in their concessions, either as regards the duration of the service or as regards the vehicles, the rates, etc.

NOTE :

The provisions of the above decrees were co-ordinated, together with previous legislation, to form the *Text of the legal provisious concerning private railways, tramways and road motor traffic* (Testo unico delle disposizioni di legge per le ferrovie concesse all'industria privata, le tramvie a trazione meccanica e le automobile), by M. Cessari (1930; Libreria di G. Pirola, Milan, Via Cavulotti 16).

The first edition of this standard text was approved by *royal decree No. 1447 of the 9th May 1912.*

This publication contains (pages 376 and following) the text of the *standard specifications* (disciplinare) for services to be granted concessions, differing for subsidised or non-subsidised services.

5. The standard texts mentioned above contain several regulations on the subsidies to be granted by the State, the provinces, boroughs, and Post and Telegraph Administration, to *public passenger services* (in particular the laws of the 30th June 1904, 16th June 1907, 12th July 1908, and 15th July 1909) (*).

(*) According to the above legislation, there are in Italy, at the present time, *four types of services for passenger transport (between towns) :*

1. *Definitive services* with fixed itineraries, authorised for a period of nine years, with or without a subsidy from the Government;

2. *Provisional services*, over fixed itiner-

6. Amongst the provisions on the obligations of concession holders of public passenger services with fixed routes and timings, there is one worthy of special mention : that giving the public authorities which are empowered to authorise or refuse such services, the power to refuse the licence in cases when the services will compete against the railway. In cases where public interest requires the authorisation of a line in spite of its being parallel to the railway, *circular No. 7617 of the Ministry of Public Works, dated the 27th July 1928,* lays down that the railway shall share in the profits of such services.

7. *Law No. 1459 of the 5th October 1920* lays down the conditions for the transport of *mails and post parcels* by vehicles belonging to public services already in operation. These regulations were afterwards made more general and completed by *royal decree No. 671 of the 24th April 1921.*

8. As regards *rail and road co-ordination,* the Minister of Communications had taken two important steps. The first, resulting from the *decree of the 31st May 1928,* sets up a Commission notably for solving, case by case, all questions of *competition* from new motor services, long-distance tourist services or provisional services to the prejudice of the State Railways. The second measure, intended to enable the railway to fight road competition more efficaciously, results from *royal decree No. 836 of the 13th May 1929,* which *authorises the State Railways to share in undertakings whose object it is to acquire and develop railway traffic as well as to operate complementary and ancillary services.* In pursuance of this decree the State Railway Administration set up, in July 1929, a subsidiary company : « The National Transport Institute » (Istituto Nazionale Trasporti : I. N. T.) with the object of collaborating with the State Railways in order to increase their traffic as much as possible and to work a certain number of road motor services, and in particular door to door transport. *Service order No. 121 of the 1st August 1929* regulates the working of this organisation.

9. The *royal decree of the 21st December 1921* empowers the Minister of Transport to *close certain railway lines* or sections of such lines and to *substitute road services for them.* The State Railways have already made use of this power and used the I. N. T. to set up road services instead of the train services given up.

The *general safety regulations* are contained in *royal decree No. 710 of the 29th July 1909.*

Decree No. 3179 of the 2nd December 1928 completes the requirements as regards *loading gauge,* and *the length and weight of vehicles running on the public highway.*

10. As regards *fiscal charges* other than customs dues (dazii erariale) and sale taxes (tasse di vendita) on petrol, lubricating oil and tyres, the *royal decree of the 30th December 1923* introduced *a circulation tax* (tasse di circolazione) based

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aries, authorised for a period of six months, which can be renewed at the end of this period, without any subsidy from the Government;

3. *Long-distance tourist services*, authorised year by year, without any subsidy from the Government, but with the right of sharing in premiums as laid down in the terms of the concession;

4. *Seasonal services*, operated during a period of varying length, also to cover the tourist traffic, but without the luxury character of the services coming under point 3, requiring either an authorisation every year. or else, in some cases, receiving a definite concession; in the latter case, these services are also entitled to a subsidy.

on the horse-power and varying according to the nature and use made of the vehicle (private motor cars, motor cars for hire, buses used in services with fixed itineraries, lorries, trailers). The provisions of the abovementioned decree are partly amended by the *new decree of the 3rd December 1934, No. 1984.*

The *tax on trailers* is an annual fixed duty; as from the 1st April 1934, it has been increased by a supplement calculated on the loading capacity.

11. The development of the motor in Italy is *encouraged* by various measures of a fiscal nature. The *royal decree No. 457 of the 25th April 1932* encourages the sale of small vehicles. Another *decree of the 30th May 1932,* with the object of increasing the number of heavy vehicles (incremento del Automobilismo pesante) favours the sale and maintenance of heavy lorries by abolishing for three years the circulation tax on motor lorries with diesel engines, on six-wheeled lorries with four engines, and lorries purchased by private firms from the army. The War Ministry is also authorised to grant the owners of heavy lorries annual premiums for good maintenance.

12. On the other hand, a *contribution towards the maintenance of the roads* is imposed by *royal decree No. 1175 of the 14th September 1931* on the users (factories, traders, hauliers, etc.) whose transports (of at least 1 000 tkm. [611 Engl. ton-miles] per year) is of such kind as to cause exceptional wear of the roads (un eccezionale logoro delle strade).

Poland.

1. The essential legislation is contained in the *law of the 14th March 1932* on the transport of passengers and goods by motor vehicles for reward (Ustawa o zarobkowym przewozie osób i towarów pojazdami mechanicznemi) published in the *Law Compendium* (Dziennik Ustaw), No. 32 of the 18th April 1932. The details of the *application* of this law were the object of an *order* issued by the Minister of Communications on the 6th July 1932, published in the *Law Compendium* No. 95 of the 31st October 1932.

2. A later order issued by the Minister of Communications and the Minister of the Interior, in agreement with the Minister of War, on the 13th August 1932 (Rozporzadzenie w sprawie regulaminów przewozu osob i ich bagazu oraz towarów pojazdami mechanicznemi) contains the *regulations for the transport of passengers and their luggage,* as laid down in the law of the 14th March 1932.

3. The safety of road motor transport is the subject of clauses in the *law of the 7th October 1921 on the highway code* (Ustawa o przepisach porzadkowych na drogach publicznych), published in the *Official Gazette,* No. 89 of the year 1921.

The *omnibus traffic* on public highways is regulated, from the point of view of *safety,* by a decree issued by the Minister of Communications and the Minister of the Interior, in agreement with the Minister of War, on the 5th August 1932 (Rozporzadzenie o ruchu autobusów na drogach publicznych), published in the *Official Gazette,* No. 267 of the 21st November 1932.

4. The *contributions* of owners of motor vehicles, as well as motor transport firms, towards the construction, reconstruction, and *maintenance of the public highways* are fixed by the law of the 3rd February 1931, modified by the law of the 29th March 1933 (Ustawa o Pañstwowyn Fundaszu Drogowym). The definitive text of this law is given in the *Law Compendium* No. 45 of the 26th June 1933.

In addition, an order issued by the President of the Republic on the 21st October 1932 (Rozporzadzenie o premjowaniu pojazdów mechanicznych), published in the *Law Compendium* No. 91 of the 26th October 1932, lays down the *conditions under which are allocated the premiums to be granted to the owners of motor vehicles the construction and design of which meets the special requirements for the defence of the country.*

Note : The orders of the 5th and 13th August 1932 contain, amongst others, a certain number of regulations on the construction and arrangements of vehicles, as well as the character of the driver, such regulations being intended to assure the safety of the service.

The law of the 29th March 1933 includes regulations on the tax on motor vehicles of all kinds and the fiscal charges upon public road services.

Rumania.

1. Road transport is generally regulated by the *law on the operation of public road transport services by mechanically-propelled vehicles* (Legenpentru exploatarea serviciilor de cărăusie publica de drŭmŭri prin véhicule cu tractiune mecanică) of the 11th June 1930, modified and completed by a law passed on the 15th October 1932.

The essential regulations for the application of this law are contained in a *standard specification* (Caiet de sarcini-tip relativ la exploatarea serviciilor publice, regulate cu vehicule cu tractiune mecanica, pentru transporturi de pasageri si bagaje) for the agreements between the State and the concession holders, to whom the exclusive right of operating public services over a given route has been given by tender.

2. The road *law of the 20th April 1932* (Lege pentru drŭmŭri) published in the *Official Gazette*, No. 96 of the 22nd April 1932, fixes the *charges* upon vehicles *with mechanical traction* and their operation, to add to the « credit » side of the budget of the *National Roads* Administration, as well as that of the provincial and local roads.

3. The law of the 20th April 1932 also contains general regulations on the *highway code and road traffic.*

Detailed requirements as to the construction of road vehicles are the subject of a *special regulation* drawn up by the Minister of Public Works and Communications.

4. A law promulgated on the 21st July 1934 (Lege pentru autorizarea Ministerlui de Lucrari Publice si Comunicatii de a concesiona Regiei Autonome C.F.R. exploatorea exclusiva a cărausiei publice de călători, bagaje si mărfuri pe unele drŭmŭri) authorises the Minister of Public Works and Communications to grant the *Rumanian State Railways Management the exclusive licence* for operating (directly) *over a certain number of roads* (most of which are parallel to the railway) *public road services for passengers, luggage and goods,* according to an agreement to be come to between the said Minister and the Rumanian State Railways.

The *agreement* described above was drawn up in *August 1934* and it gives a list of 155 road sections reserved for the exclusive operation of public omnibus and lorry services by the *Rumanian State Railways* themselves.

Switzerland.

1. The *federal law of the 2nd October 1924* gave the *Post Office Administration* the *exclusive right* of operating *regular road transport services for passengers,*

either themselves or through concession holders. This law fixes the procedure to be followed to obtain such concessions.

2. *The order issued in pursuance of the above law*, published *on the 8th June 1925*, has been modified and completed by several *decrees issued by the Federal Council*, dated the 23rd February 1926, 30th April 1926, 5th January 1927, 14th October 1933, and 30th January 1934.

3. The *federal law of the 15th March 1932* (which came into force on the 1st January 1933) on *automobile and motor cycle traffic* gives first of all police regulations intended to increase the *safety* of road traffic, and then deals with such questions as responsibility and obligatory insurance, working hours of drivers, the speed, weight, and dimensions of vehicles;

4. The application of the above law was the subject of a first *decree issued by the Federal Council*, which also came *into force on the 1st January 1933*, and was followed by another *decree* relating more particularly to working hours and rest periods for professional drivers, dated the 4th December 1933 and put into force on the 1st July 1934;

5. As regards *co-ordination* of the different methods of transport, the first step taken was by the *federal law of the 23rd January 1934* regulating the *transport of goods on public highways by motor vehicles*, which will probably come into force during 1935 and be applied in several stages;

6. The *fiscal charges* upon motor vehicles, except the duty on petrol, are not laid down by any single federal law, but are the subject of *cantonal legislation*. Although the taxes imposed differ considerably in the different cantons, the base for the tax on motor vehicles is the same, i.e. their horse-power. Only the cantons of Basle and Geneva take the loading capacity of lorries as the basis. One quarter of the *duty on petrol* is handed over to the cantons as a subsidy from the Federation towards the maintenance of the roads, the cost of which is borne by the cantons.

A synoptic table of the taxes on motor vehicles, giving the averages for the whole country, was published in 1931 by the *Swiss Association of Motor-Lorry Owners*.

Czechoslovakia.

1. The legislation in Czechoslovakia is based in general on the *law on road motor transport* (Zákon o dopravé motorovými vozidly) of the 23rd December 1932, published as No. 198 of the *Law Compendium* of the year 1932.

The details of the *application* of this law were the subject of a governmental *order* issued on the 16th February 1933, and published as No. 36 of the Compendium for the year 1933.

2. The *highway code* is the subject of the *ministerial order* No. 81 of the year 1910 for the former Austrian Empire, and of a similar decree, No. 57000, also issued in 1910 for former Hungary, these two orders forming up to the present time the bases of the Czechoslovak law. They were completed by a *Czechoslovak law* on the 16th July 1931, No. 120, followed by an order on the 30th June 1932, No. 107 (1).

The *contribution of owners* of motor vehicles as well as motor transport firms towards the construction, reconstruction,

(1) A new *special law on motor traffic*, inspired by the principles of the international convention made in this connection, is being prepared.

and maintenance of the public highways is fixed by the *law of the 14th July 1927*, No. 116, completed and modified by the *law of the 7th May 1931*, No. 76 (Zákon o silničním fondu).

These two laws also deal with the tax on tickets issued to motorbus passengers, but the law of the 23rd December 1932 altered the regulations in question by modifying their object [1].

4. The *responsibility* of owners of mechanically-propelled vehicles and of those using them or driving them are regulated by the *former Austrian law No. 162, of the 9th August 1908*, followed by *decree No. 221 of the 28th October 1908*, which lessened the obligations imposed by the former law on owners of vehicles running at low speeds. Another *decree* dated *the 13th October 1927*, No. 156, completes law No. 162 of the 9th August 1908.

The obligation to take out an insurance policy is imposed, on those operating public road services, by the law of the 23rd December 1932, the conditions of which are specified in the order of the 16th February 1933.

Jugoslavia.

1. In Jugoslavia, special legislation on public transport was introduced by the law of the *12th December 1930 on firms undertaking* regular or seasonal *transport of passengers and goods in motor vehicles* (Zakon o preduzečima za redovan ili povremen prevoz putnika i robe motornim kolima).

However, except for clause 8, this law was rescinded and replaced by a new general law, the *law on undertakings* (Zákon o radnjama) which included nearly all the essential regulations of the former law, together with a few new ones.

§ 60 of the above general law puts motor transport firms in the same position as the other firms covered by this law as regards the necessity of obtaining a licence. The general regulations laid down in §§ 61, 62, and 65 notably are applicable to such firms in particular. The first two paragraphs fix the conditions to be fulfilled by those applying for concessions, as well as the administrative procedure for granting authorisations; the last clause covers the control of the firms to which an authorisation has been granted. Two other paragraphs (§§ 102 and 103) name the authorities granting the concessions in general, and those for public road motor transport in particular. These paragraphs replace the corresponding paragraphs in the law of the 12th December 1930, and in particular the regulations contained in § 1, clauses 2 and 3, and §§ 2, 4 and 9.

Clause 1 of § 82 of the law on undertakings makes it obligatory for road motor transport firms to take out an insurance policy to cover their responsibilities towards their clients, and third party risks. Clause 2 of § 82 obliges the aforementioned undertakings to transport mails and to organise, with the help of the State, public services on new roads which are of importance for tourist traffic. Class 3 of this paragraph obliges firms operating tourist services to use suitable stock and the last clause lays down the scale fixing the total sum to be paid by the firm as a guarantee.

The *law on undertakings* lays down in § 83 that the Minister of Commerce and Industry, in agreement with the Ministers of the Interior, the Minister of Public Work, the Minister of Communications,

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[1] A revision of the law of the 23rd December 1932 in hand; it also covers the fiscal charges laid down by the laws of the 14th July 1927 and 7th May 1931 quoted above.

and also the Minister of Public Health, is to fix by means of *Regulations* the details of the working of transport undertakings, the scales for granting concessions to such firms, the insurances they are to take out, the vehicles to be used, and finally the control of all such firms.

(These regulations, which are to be issued as a decree for the applications of the *law on undertakings*, are under preparation).

2. *Occasional transport of goods by motor lorry*, worked professionally, is regulated by a *decree issued by the Minister of Commerce and Industry*, dated the *10th May 1934*, on the basis of clause 60 of the law on undertakings (Uredba o izdavanju dozvola za neredovan [povremen] prevoz robe motornim kolima).

3. Professional transport by omnibus and lorry, of passengers and goods, is subject to a *transport tax*, imposed by the *law of the 20th February 1934*, modifying the corresponding paragraph of the *law on taxes*.

In pursuance of the general regulations (§ 22) of the law on national roads, as well as a similar provision (§ 33) of the law on other public highways, which lays down that the users shall pay a *contribution towards the maintenance of the roads*, the Minister of Public Works issued, in December 1930, a *decree on the payment of the said contribution* (Upustva za naplatu vanrednog doprinosa za održvanje državnih i nedržavnih javnih putova) which contains the special provisions for public motorbus services and the carriers of goods by motor lorry.

[625. 1 (.45) & 625. 13 (.45)]

The new Bologna-Florence "Direttissima" line.

The Italian review « Annali dei Lavori pubblici » *devoted its January issue to a detailed description of the new Bologna-Florence* « *Direttissima* » *line which was opened to traffic in April 1934. We think it will be of interest to give a brief account of this line with photographs and pictures so that our readers can judge the great importance and interest of this work, brought to a successful conclusion by the Italian State Railways.*

The completion of this difficult work has once more proved the outstanding ability of Italian engineers and contractors in this connection.

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As far back as 1852, when studying the location of the railway line between Tuscany and Emilia, a direct line was considered, with heavy gradients, through the Setta and Bisenzio valleys.

The present location through the Porrettana was given the preference. The line was hardly open to traffic, however, when it was realised how inadequate it was for good and fast services between the Capital and the Po valley.

Before the war, the question was reconsidered and work begun to locate a Florence-Bologne « Direttissima » line. This work, which was greatly hindered by the war, was continued half-heartedly after the armistice, during the social crisis which Italy underwent. As soon as the Fascist Government came into power, it realised the importance of the new line and the work was hastened on with great activity until the line was completed and put into service on the 22nd April, 1934.

Taken as a whole, the « Direttissima » starts from the Bologna station and runs into the old Pistoja-Florence line near the Prato station.

Its chief characteristics are as follows :

a) double track throughout;

b) no level crossings;

c) gradients less than 1 in 83, reduced to 1 in 125 in the tunnels (1 in 173 in the Apennine tunnel);

d) radius of curves not less than 800 m. (40 chains) on the Bologna-Castiglione dei Pepoli section, and 600 m. (30 chains) over the rest of the line;

e) stations with holding sidings 500 m. (1 640 feet) long;

f) rails of the F. S. P. type weighing 50.6 kgr. (102 lb. per yard), 18 m. (59 ft. 5/8 in.) long on 30 sleepers;

g) electric traction.

Table I below gives the chief characteristics of the new through line in comparison with corresponding data for the present Porrettana (via Pistoja) and Faentina (via Faenza) lines.

Fig. 1. — Crossing the Setta valley at Vado.

Fig. 2. — Crossing the Farnetola. — The Grizzana station.

Fig. 3. — The Cà Landino workings (working on the large tunnel by means of shafts).

Fig. 4. — View of the line.

Fig. 4a. — View of a pylon.

Figs 4 and 4a. — Telpher line between the northern portal of the great tunnel and the Cà Landino shafts.

Fig. 5. — Excavating material for the embankment at the Prato station. Bucket excavator.

TABLE I.

CHIEF CHARACTERISTICS OF THE « DIRETTISSIMA » AND THE *PORRETTANA* AND *FAENTINA* LINES.

Porrettana—Bologna-Pistoja-Florence.
Faentina—Bologna-Faenza-Florence.
Direttissima—New Bologna-Prato-Florence line.

Features.	Direttissima.	Porrettana.	Faentina.
Actual length	96 km. *(59.6 miles).*	131 km. *(81.4 miles).*	150 km. *(93.2 miles).*
Virtual length	124 km. *(77.1 miles).*	219 km. *(136.1 miles).*	250 km. *(155.4 miles).*
Length of single track	—	109 km. *(67.7 miles).*	100 km. *(62.1 miles).*
Length of double track	96 km. *(59.7 miles).*	22 km. *(13.7 miles).*	49 km. *(30.4 miles).*
Length of tunnels	36 km. *(22.4 miles).*	18 km. *(11.2 miles).*	23 km. *(14.3 miles).*
Radius of curves	600 m. *(30 chains).*	300 m. *(15 chains).*	300 m. *(15 chains).*
Maximum gradients :			
in the open	1 in 83.	1 in 38.	1 in 43.
in tunnels	1 in 125.	1 in 40.	1 in 40.
in stations	1 in 400.	1 in 38.	1 in 333.
Motive power	Electric.	Electric.	Steam.
Rails	50.6 kgr. *(102 lb. p. y.).*	36 kgr. *(72.6 lb. p. y.).*	36 kgr. *(72.6 lb. p. y.).*

In addition to the construction line in the Setta and Bisenzio valleys, a telpher line 9 km. (5.6 miles) long rising 262 m. (860 feet), was built on the steepest part of the Apennines in order to facilitate the construction of the tunnel near the Cà di Landino inclined shafts. This telpher could transport 27.5 tons of material per hour; it was fitted up in 1924 and worked until the end of 1931, when it had carried 75 000 tons of material.

Special attention was paid to the sanitary services at the workings; hospitals fitted with all necessary modern equipment were set up on the job.

Special medical precautions were taken to avoid infection from miners' worm — anchilostoma duodenale — which is not unknown in this region. It may be remembered that 10 000 workmen died from this infection during the work on the St. Gothard.

The precautions taken proved so efficacious that no cases of this illness were reported during the whole period of working.

The most important and difficult constructional work on the line was the long tunnel through the Apennines. As regards length it is comparable with the Simplon tunnel, but the conditions under which it was driven are completely different. The Simplon tunnel is formed of two single-track sections which are separate and some distance apart, and bored at a great depth through primary rock; the hardness of the rock, the high temperature, and the springs of warm water were the chief preoccupations.

The Apennine tunnel, on the other hand, is a double-track tunnel driven through tertiary soil with heavy thrust. Inflammable gases and serious flooding had to be dealt with. Table II below

Fig. 6. — Compressed-air locomotive (large type) for traction in the great tunnel.

Fig. 7. — Logaro working. — Sulzer ventilators of 24 m³ (847.5 cu. ft.) per second capacity.

Fig. 8. — Ventilators in the great tunnel.

Fig. 9. — Timbering in the top workings.

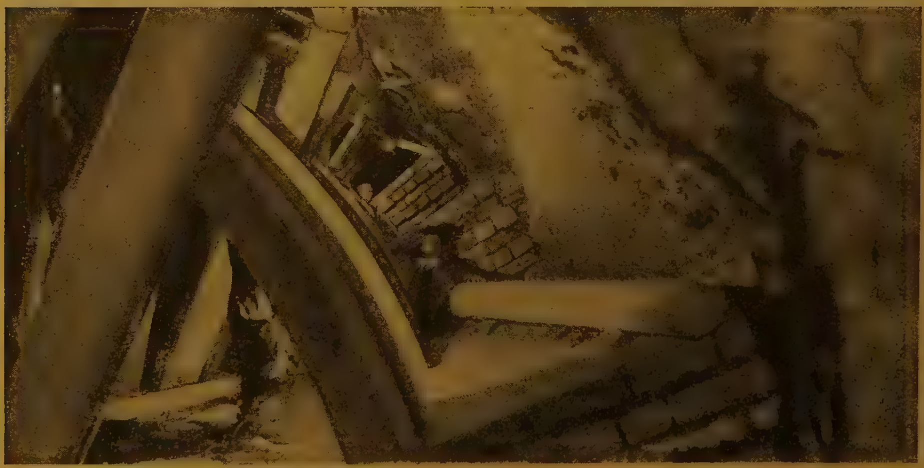

Fig. 10. — Masonry work on the roof.

Fig. 11. — Metal centring of the roof work.

Fig. 12. — Wooden centring of the roof work.

Fig. 13. — Timbering of the roof.

gives comparative information about the new tunnel and other noteworthy long Alpine tunnels.

TABLE II.

CHARACTERISTICS OF SOME OF THE ALPINE TUNNELS AND THE NEW TUNNEL UNDER THE APENNINES.

Tunnel.	Line.	Length, kilom. *(miles)*.	Single or double track.	Layout.	Maximum gradients.	Monthly progress.	Cost of construction in lire, per linear metre *(per foot)*.
Fréjus 1857-1870.	Turin-Modane.	13.635 km. *(8.472 m.)*.	Double track.	Straight.	Italy, 1 in 1 000. France, 1 in 36.3.	150 m. *(492 ft.)*.	5 500 *(1 676)*.
St.-Gothard 1871-1880.	Chiasso-Lucerne.	14.920 km. *(9.271 m.)*.	Double.	Do.	1 in 172.	210 m. *(689 ft.)*.	4 500 *(1 372)*.
Arlberg 1880-1883.	Innsbruck-Berne.	10.280 km. *(6.388 m.)*.	Double.	Do.	1 in 66.	326 m. *(1 070 ft.)*.	4 864 *(1 483)*.
Simplon. 1898-1905.	Domodossola-Brig.	19.802 km. *(12.305 m.)*.	2 headings, single.	Do.	Switzerl, 1 in 500. Italy, 1 in 143.	247 m. *(810 ft.)*. (on 1 tun.).	5 000 *(1 524)*.
Loetschberg 1906-1911.	Brig-Berne.	14.536 km. *(9.032 m.)*.	Double.	Mixed.	1 in 143.	373 m. *(1 224 ft.)*.	3 500 *(1 067)*.
Apennine 1920-1934.	Bologna-Florence.	18.507 km. *(11.500 m.)*.	Double.	Straight.	1 in 172.	190 m. *(623 ft.)*.	25 000 *(7 620)*.

As stated above, the nature of the ground varied much, and included shale, clay, marl, sandy clay, macignos, etc...

As a rule, the conditions found during the work were in agreement with the information provided by the preliminary geological survey.

The boring of the tunnel was begun from the two ends and through the top of the mountain by means of two inclined shafts.

The table below gives some idea of the power installed on each of the workings.

TABLE III.

TABLE OF THE POWER INSTALLED IN THE TUNNEL WORKINGS UNDER THE APENNINES.

—	Northern side.	Inclined shaft at Cà di Landino.	Southern side.	Total.
High-pressure compressors . . . H.P	570	790	740	2 100
Low-pressure compressors for boring H.P.	350	1 050	700	2 100
Ventilation . . . . H.P.	670	940	510	2 120
. . . .	. . . . .	. . . . .	. . . . .	. . . . .
Total . . . H.P.	1 825	10 225	2 400	14 450

Figs. 14 and 14*a*. — The twin inclined shafts at Cà Landino.

Fig. 14. — Upper opening of one of the shafts with view of a trolley.

Fig. 14*a*. — Double passing siding for the trolleys.

Separate equipment and mains were provided to feed compressed air to the drills, to the traction motors, and also for ventilation.

The drilling was done with compressed-air hammers under a pressure of 7 atm. (100 lb. per sq. inch).

Compressed air motors with a pressure of 14-15 atm. (199-213 lb. per sq. inch) were used for haulage.

Middle section for the passing station.

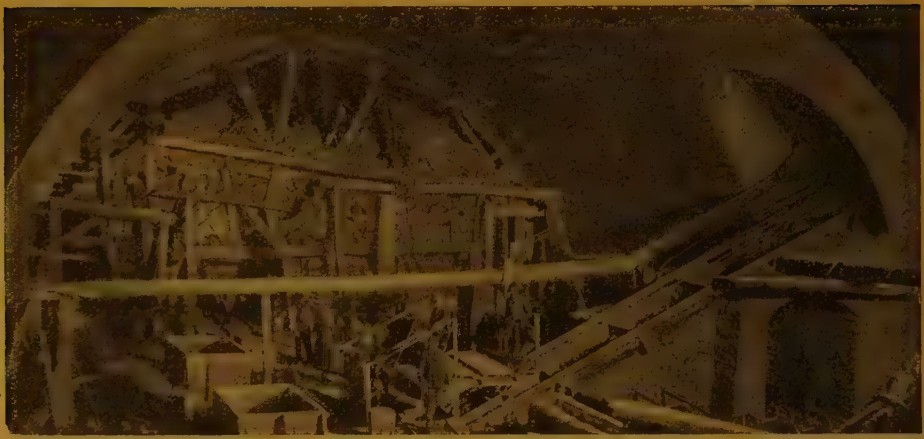

Fig. 15. — Construction and view of a shaft.

Fig. 16. — End section, on the Florence side, of the subterranean passing station.

Fig. 17. — Waterproofing the roof of the great tunnel.

Figs 18 to 20. — The flooding at the 5.833th km. (3.63 miles) from the Florence end.

Fig. 18. — View of the spring; flow: 250 litres (3.53 cu. feet) per second.

Fig. 19. — Masonry dam built in front of the spring.

Fig. 20. — Arrangement to break the force of the water from the spring.

Fig. 21. — Fire caused by gas at a point 3.07 miles from the Bologna end of the great tunnel. The vaulting invaded by the flames.

Fig. 22. — Viaduct over the Setta, near Vado, with 7 arches of 20 m. (65 ft. 7 3/8 in.) span, and 7 of 25 m. (82 ft. 1/4 in.).

Fig. 23. — Viaduct over the Setta near Vado. — Detail.

Fig. 24. — Bridge over the river Farnetola, with 11 arches of 20 m. (65 ft. 7 3/8 in.) span, and one of 12 m. (39 ft. 4 1/2 in.).

Fig. 25. — Skew bridge over the river Bisenzio, with 3 arches of 11 m. (36 ft. 1 in.) span, and one of 12 m. (39 ft. 4 1/2 in.).

Fig. 26. — Portal of the great tunnel, on the Florence side.

Fig. 27. — Passenger station buildings at Prato. — Town facade.

Fig. 28. — The Prato station.

The average volume of air used for ventilation during twenty-four hours was :

1 645 000 m³ (58 093 175 cu. feet) at the northern end;

1 555 000 m³ (54 914 825 cu. feet) in the inclined shafts;

970 000 m³ (34 255 550 cu. feet) at the southern end.

The Belgian method was mainly used in driving the tunnel.

The average progress was 1.91 m. (6 ft. 3 3/16 in.) from the northern end, 3.34 m. (10 ft. 11 1/2 in.) in the shafts, and 2.32 m. (7 ft. 7 3/8 in.) from the southern end.

In addition, alongside the tunnel properly speaking, a long siding section was driven near the inclined shafts to form a passing station 1 224 m. (1 338 yards) long.

The greatest difficulty that had to be overcome in driving the tunnel was due to escapes of gas and flooding.

Figs. 29 to 31. — Electrification of the line.

Fig. 29. — 60-kV. primary line on the Vergato-Grizzana section.

Fig. 30. — Grizzana sub-station. Part seen uncovered at the beginning of the 60-kV. primary groups.

Fig. 31. — Locomotive in service on the Direttissima.

The gas was mainly composed of methane (97 %) and nitrogen, which accumulated in the high parts between the timbering, was very inflammable, and exploded when mixed with the right proportion of air.

In spite of the precautions taken and the very strict rules observed in the workings, there were several unfortunate fire outbreaks.

Among the precautions taken, the following may be mentioned :

1) the use of electric accumulator lamps;

2) gas warning lamps;

3) distant electric blast firing;

4) installation of fire protection water mains under pressure;

5) transport by compressed air locomotors;

6) gas exhausters.

Together with the gas, severe flooding gave rise to serious difficulties when carrying out the work.

Additional work was necessary in order to render the lining waterproof by injecting cement mortar under pressure, with or without water-resisting products added to it.

Although the tunnel under the Apennines is the most important work on the line, there are also a great many masonry viaducts, as well as metal and concrete bridges.

To complete these structures, 490 000 m^3 (640 920 cu. yards) of masonry were

Figs. 32 and 33. — Electric power signalling.

Fig. 32. — Shunting box at the S. Ruffillo station. — Illuminated control board.

Fig. 33. — Semaphores, protecting the Grizzana station near Bologna, fitted on one of the electric-traction gantries.

used. Brickwork with hydraulic lime mortar was chiefly used.

Among the more important viaducts mention must be made of the Setta viaduct at Vado, a bridge over the Farnetola river, and two skew bridges over the Bisenzio river.

Fig. 34. — Starting signals, at Grizzana station, on a bracket post.

Protective works had to be carried out in the cuttings and on embankments, and several tunnels of lesser importance than the long Apennine tunnel had to be driven.

Several intermediate stations were built between Bologna and Prato; the latter had to be especially equipped as termini for the new « Direttissima » line. The intermediate stations are on the average 10 km. (6.2 miles) apart; they are 700 to 1 200 m. (766 to 1 312 yards) long, and are placed on level stretches of line or large-radius curves (1 000 to 1 400 m. = 50 to 70 chains) on gradients of not more than 1 in 666 to 1 in 400. At each of these stations there is a holding siding 500 m. (547 yards) long and a passenger subway between the platforms 3 m. (9 ft. 10 1/8 in.) wide.

As we have already mentioned, there is also a passing loop about the middle of the Apennine tunnel.

The new line is electrified. It was estimated that, in any case, the trains could not be hauled through the long tunnel by means of steam traction, unless important ventilation equipment was installed.

In considering the various systems, the choice fell on electrification using direct current at 3 000 volts, with overhead contact wire.

The signalling of the new line is worked on the automatic block system, the block sections being 4 to 5 km. (2.5 to 3.1 miles) long; the block signal is doubled by a warning signal at a distance of 450 to 300 m. (492 to 328 yards), according to the local conditions.

In the stations the starting signal is also the block signal.

R. DESPRETS.

[621. 131. 3]

Results of recent steam locomotive tests,

by Prof. Dr.-Ing. H. NORDMANN, Reichsbahnoberrat, Berlin.

(VDI. Zeitschrift des Vereines Deutscher Ingenieure.)

As locomotives of unusual types, designed to obtain much higher heat efficiency, have given rise to many difficulties, and as fuel costs are a relatively low proportion of the total operating expenditure, good locomotives of normal types are being better appreciated. The author deals with their fuel consumption and gives data collected recently on locomotives with more than two cylinders and compound locomotives. He shows that the thermal advantage of double expansion is very restricted and conditional. He examines the efficiency as expressed by the ratio of the drawbar horse-power to the indicated horse-power, and explains how this efficiency can be increased, in view of very high speeds, by streamlining. He describes fast runs made by simple-expansion locomotives of ordinary design.

Evolution of the steam locomotive as regards heat economy.

When the locomotive tests recently carried out by the Reichsbahn are examined, it is noticed, probably with surprise at first, that they only deal with locomotives of standard design, i.e. lomotives with pistons and direct exhaust, with a boiler of the usual type. This is not mere chance. The Reichsbahn wished to mark a stage in locomotive development and the tests were not only intended to give a general review of modern theories of locomotive construction, but contributed largely to raise such theories.

Some ten years ago it was possible to foreshadow *two* lines of evolution. One concerned the normal design. Through the Reich taking over the railways in the different States, the possibility of a 20-ton axle load on many of the trunk lines, finally and especially unification and standardisation, produced many new schemes amongst which those in connection with the express and heavy goods locomotives were the first to materialise.

The standard locomotive designs, and soon after the designs for engines with lighter axle loads, provided for well thought-out boilers with large superheaters, it is true, but what was really sought for was to provide good locomotives for future working rather than exceptional results in the way of heat economy. Now, at that time heat economy — considered more or less alone — was of general interest even in the construction of stationary engines. In this way we assisted to a second orientation of the evolution, naturally at first only applicable to some *experimental locomotives* which, by extending the temperature or pressure drop range, are expected to give a greatly increased thermal efficiency. We would mention the turbine and ultra-high-pressure locomotives (1) to which was added, though outside the field of the steam locomotive, the diesel locomotive (2), whereas the locomotive burning pulverised coal (3) had an ordinary boiler fitted with a pulverised-coal burner and a tender of an unusual design. In addition to the expected slightly higher boiler efficiency, the latter experiment represented

(1) See H. NORDMANN, *Z. VDI*, vol. 74 (1930), p. 173; Fr. WITTE and R. P. WAGNER, *Z. VDI*, vol. 74 (1930), pp. 1073 and 1141.

(2) See M. MAYER, *Z. VDI*, vol. 76 (1932), p. 705.

(3) See H. NORDMANN, *Z. VDI*, vol. 73 (1929), p. 951.

another kind of evolution in heat economy, the desire to use inferior quality fuel (lignite finely divided and dried, or pulverised semi-coke).

The Deutsche Reichsbahn must be given credit for having undertaken these experiments on a large scale, and for having neglected none of the possible forms of evolution of the locomotive. At the 1930 (Madrid) Session of the International Railway Congress Association, the question of improving the thermal efficiency of locomotives occupied much place and the German report (4) was the fullest : it was in fact the only one to give the results of large-scale trials.

No definite conclusion was come to at that time. Economic theories have changed moreover. As in the case of stationary plants, the idea of heat economy alone has given place to an investigation into the *overall economy*.

In one of the German reports (5) for the Second World Power Conference, Berlin 1930, F. FUCHS gave the locomotive running costs on the Reichsbahn for 1929, the most striking feature of which was that the fuel cost was only 23 % of the total locomotive expenditure; besides a few less important items such as feed water and oil, the charges were given under three main headings : capital charges, maintenance, and enginemen's wages. Since that time, the cost of coal still dropped to 21 %; in other words the results obtained by improving the thermal efficiency only affect one quarter to one fifth of the total locomotive costs. In a second report (6) for this Conference, we pointed out that improvements in thermal efficiency are only fully reflected in the *overall economy* of the locomotive when the other charges are not increased thereby, i.e. when they are not cancelled by higher capital and maintenance costs, owing to a more complicated design.

The fact that the designs put forward were very ingenious and well thought out could not remedy this, the weak point. NAJORK and WICHTENDAHL have shown (7) that on ultra-high-pressure locomotives, the heat saving, considered by itself, has to be much higher than anything so far obtained in trials if it is to compensate for the higher capital and maintenance costs.

Then too, locomotives of new types have the inherent defect that any unexpected failure in service, unavoidable even with the most reliable locomotives, means not only a reduction in the heat saving owing to cooling down and relighting up the boiler, but also involves the use of a spare engine. Nowadays, through the severe competition from other vehicles and methods of transport, anything upsetting regularity of working is particularly harmful. For all these reasons the value, as a system, of the new types of locomotives which in spite of their small numbers were very highly esteemed a few years ago, has fallen considerably. Evolution will not stop, however, though it will not be so rapid as before, and the operating service will not count on such engines, at least for the present. The pulverised-coal locomotives are the only ones which have passed the tests so far and are continuously in service, but they have the usual type of boiler and cylinders.

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(4) H. NORDMANN, *Bulletin of the International Railway Congress Association*, January 1930, p. 259.

(5) F. FUCHS, « Die Entwicklung des Dampf-Lokomotivparks der Deutschen Reichsbahn » (The evolution of the Deutsche Reichsbahn locomotive stock). Second World Power Conference, vol. 17, Berlin, 1930, p. 53 (German edition).

(6) H. NORDMANN and R. P. WAGNER : « Druck- und Wärmegefälle der Dampflokomotiven in ihrem Einfluss auf bauliche Durchbildung und Wärmewirtschaft. Gesammtbericht 2 » (The effect of pressure and temperature drop on the design and thermal economy of locomotives. General report No. 2). Second World Power Conference, vol. 17, Berlin, 1930, p. 66 (German edition).

(7) E. NAJORK and R. WICHTENDAHL, *Z. VDI*, vol. 74 (1930), p. 1645.

Under such conditions, the value of the usual types of locomotive must necessarily rise considerably and the work of perfecting the old tried design of locomotive in its details, while retaining its present form of construction, has been given the first place, even in the tests.

Any better thermal results obtained in this case are also, at least to a large extent, an overall saving, as they are not accompanied by any marked increase in the capital and maintenance costs.

Then too, the investigation work is of value from such purely practical points of view as suitability for high speeds or the more accurate demarkation of the field of utility of locomotives with two, and those with more cylinders. As known factors are usually in question, successful results can be applied straight-away to the next batch of locomotives built, whereas in the case of any unusual design, the behaviour of the locomotive under the ideal conditions at Grunewald must be confirmed by prolonged service trials before an order of any importance can be justified, and consequently before profiting to any appreciable extent by the possible savings.

The rest of this article therefore will consider the usual type of locomotive from new angles, based on recent tests at Grunewald.

Consumption figures and their dependence on the steam pressure and temperature.

This leads up to the question of knowing how the consumption figures of modern Stephenson-type locomotives (8) should be shown and how far the heat efficiency can be increased without exceeding the limits of pressure and temperature for the normal type of locomotive, especially with the usual design of boiler. As the Maffei turbine locomotive (9) was already fitted with a normal design of boiler at 22 kgr. (312.9 lb. per sq. inch) pressure and a copper firebox, we can now hope to use a pressure of 25 kgr. (355.6 lb. per sq. inch) in a boiler built of special steels, firebox included. We already know the thermal results given by the 6 German engines built for experimental purposes, different materials being used in the construction of the boiler. The same remarks apply to the 4-cylinder compound express locomotive already mentioned in the technical press many times (10).

(8) The text and figures mainly relate to the following types : — *Class 01*, heavy standard 4-6-2 two-cylinder engine, simple expansion, axle loading 20 tons, boiler pressure 16 kgr. (227.6 lb. per sq. inch); — *class 02*, heavy standard 4-6-2 express engine, compound, 4 cylinders, axle loading 20 tons, boiler pressure 16 kgr. (227.6 lb. per sq. inch); — *class 03*, light standard 4-6-2 express locomotive, two cylinders, simple expansion, axle loading 17 tons, boiler pressure 16 kgr. (227.6 lb. per sq. inch); — *class 04*, 4-6-2 express locomotive, 4 cylinders, compound, boiler pressure 25 kgr. (355.6 lb. per sq. inch) (experimental locomotive); — *class 17 (265), S 10*, 4-6-0 express locomotive (Prussian), 4 cylinders, compound, boiler pressure 15 kgr. (213.3 lb. per sq. inch); — *class 18, S 3/6*, 4-6-2 express locomotive (Bavarian), 4 cylinders compound, 18 tons, 16 kgr. (227.6 lb. per sq. inch); — *class 38 P 8*, 4-6-0 passenger locomotive (Prussia), 2 cylinders, simple expansion, pressure 12 kgr. (170.7 lb. per sq. inch); — *class 39 P 101*, 2-8-2 passenger locomotive (Prussia) three cylinders, simple expansion, pressure 12 kgr. (170.7 lb. per sq. inch); — *class 43*, standard 2-8-0 goods locomotive, 2 cylinders, simple expansion, axle load 20 tons, pressure 14 kgr. (199 lb. per sq. inch); — *class 44*, standard 2-10-0 goods locomotive, 4 cylinders compound, axle load 20 tons, pressure 25 kgr. (355.6 lb. per sq. inch) (experimental locomotive); — *class 85*, standard 2-10-2 goods tank engine, simple expansion, three cylinders, axle load 20 tons, pressure 14 kgr. (199 lb. per sq. inch).

(9) See K. Imfeld, *Z. VDI*, vol. 70 (1926), p. 1565.

(10) See *VDI-Nachr.*, vol. 13 (1933), No. 11, p. 1; F. Witte, *Ztg. Ver. Mitteleurop. Einsenb. Verw.*, vol. 73 (1933), p. 431.

It is too early, however, to review as a whole the final results of boilers pressed at 25 kgr. (355.6 lb.), seeing the materials used are still giving rise to some difficulties.

How do the fuel consumption figures present themselves? Figure 1 shows as

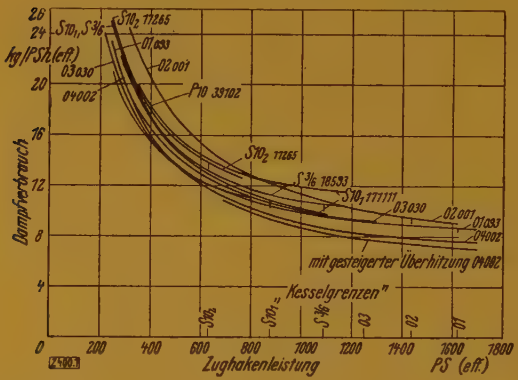

Fig. 1. — Steam consumption of different locomotives in terms of the effective horse-power. Steam production: 57 kgr. per m^2 (11.67 lb. per sq. foot) per hour at 100 km. (62 miles) an hour in terms of the drawbar horse-power. At the « boiler limit » a corresponding power is developed for a steam production of 57 kgr. per m^2 per hour. For the classes of locomotive considered here see footnote (8).

Explanation of German terms:

Kg/PSh (eff.) = kgr. per effective horse-power-hour. — Dampfverbrauch = steam consumption. — « Kesselgrenzen » = « boiler limits ». — Mit gesteigerter Überhitzung = with higher superheat. — Zughakenleistung = drawbar horse-power. — *PS* (eff.) = effective H.P.

an example, in terms of the drawbar horse-power, the weight of steam used at a speed of 100 km. (62 miles) an hour. The speed has to be taken into account especially for the reason that the steam consumption of the locomotive itself, and therefore the efficiency between the piston and the drawbar, largely depends upon the speed. A few examples are all that can be given within the restricted limits of this brief article.

The numerical data relating to weights remain of much importance because they are compiled from the original records: total steam consumption and drawbar horse-power, the first of which, in the well-proved hypothesis of a given maximum continuous output of the boiler, decides the power at the drawbar usable during a prolonged period, and thereby fixes the journey time. The way the set of consumption curves is scattered — the details of which will not be dealt with here — is due to the varying thermal efficiency of the locomotive. Each curve is also subject to certain tolerances in addition to those of the measuring instruments; it varies, for example, according as the journey is made in summer or in winter, that is to say with a different air resistance, seeing the air has a different density, or the engine mechanism is more or less worn. Then too, there is also a doubtful factor in comparing the calorific value of a kilogramme of steam, as it varies with the pressure and superheat. The best modern locomotives use on the average at 100 km. (62 miles) an hour some 9 kgr. (19.84 lb.) of steam per effective horse-power-hour at full power. The 04 class locomotive, with a boiler pressure of 25 kgr. (355.6 lb. per sq. inch) has used no more than 7.6 kgr. (16.75 lb.), and even with very high superheat obtained by means of additional tubes, 7 kgr. (15.43 lb.) per effective horse-power.

More comparable data — ignoring indicator errors — are to be found in the consumption per indicated horse power $d_i = \eta_i \, d_e$ (fig. 2) in which d_e is obtained by experiment, as we are dealing with the actual work done in the steam cylinder, and the great influence of the overall mechanical efficiency is almost eliminated. This effect is, all things considered, that of the speed, and if it is not completely eliminated, it is due to the loss through wire-drawing due to the gear increasing with the speed, whereas the loss through leakage decreases at the lower mean steam pressures obtained at high speed with re-

duced cut-off as does the wasteful exchange of heat between the steam and the cylinder walls, seeing that the time of each piston stroke is shorter. These effects act in different directions and thus partly neutralise one another, so that up to considerable speeds the value d_i is slightly reduced. However, the variation is not excessive, so that consumption figures which in their order of magnitude apply to a wide range of speeds can be quoted here.

Figure 6 gives figures of 6.1 to 6.3 kgr.

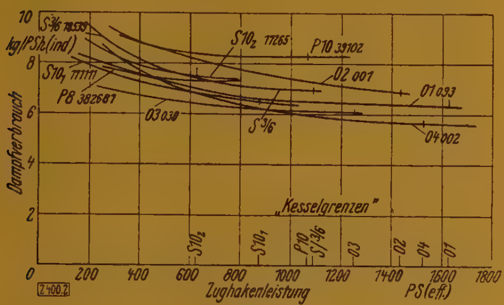

Fig. 2. — Steam consumption in kgr. per I.H.P. of different locomotives at 100 km. (62 miles) an hour.

Speed in terms of drawbar horse-power.

(13.44 to 13.89 lb.) per I.H.P., the optimum values for our locomotives using 16-kgr. (227.6 lb. per sq. inch) steam pressure and about 400° C. (752° F.) superheat. The express engine with 25-kgr. (355.6 lb. per sq. inch) working pressure and 410° C. (770° F.) superheat temperature shows 5.6 kgr. (12.35 lb.) per I.H.P., and when the superheat was carried to a very high figure only 5.1 kgr. (11.24 lb.) per I.H.P. The experimental *class 2-10-0* heavy goods engine, 25-kgr. (355.6 lb. per sq. inch) pressure, which is also a 4-cylinder compound, used even less than 5 kgr. (11.0 lb.) per I.H.P. These values expressing weights have, it is true, the disadvantage that their calorific value varies with the steam temperature. The steam consumption by weight can be converted by combining it with the calorific value of each kilogramme of steam at the measured superheated temperature, in kgr.-calories per effective horse-power-hour, in order to get a fixed value directly comparable with the calorific value of the coal. When this is done, recent locomotives, and also the good old S 10_1 class engine, show a consumption lying between 6 500 and 6 000 kgr./cal. (25 800 and 23 800 B.T.U.) per effective H.P.-hour, at 100 km. (62 miles) an hour of course; only with the 01 locomotive is the value a little less, but with the 25-kgr. pressure locomotive it does not reach 5 500 kgr./cal. (21 825 B.T.U.) per effective H.P.-hour. It is therefore better than the ultra-high-pressure engine at 60 kgr. (853 lb. per sq. inch) (two-pressure Schmidt-Henschel engine) [11] in its original form, which, it must be admitted, was the result of an ill-conceived rebuilt of a S 10_2 locomotive and only worked at full power with 50 % of actual high-pressure steam, owing to the design of the high-pressure boiler having been badly adapted as built.

On the other hand, this engine gave as good results as the turbine engine — which is to be altered and improved — at its normal working consumption, which proves that the complicated turbine locomotive was too little advance on the standard locomotive, such improvements moreover being obtainable with a first-class locomotive of ordinary design; then too, outside the normal working range, the engine works very often under much less favourable conditions than the normal design of locomotive.

Figure 3 shows the heat used in the steam in terms of indicated power, starting from the feedwater-heater temperature, that is to say deducting the heat recovered from the exhaust and restored

(11) P. Wagner, *Z. VDI*, vol. 72 (1928), p. 1521.

to the boiler. The heat used, shown by the indicator cards, has the good feature that it is little influenced by the speed, and gives therefore values more generally applicable, unlike the kgr./calories per effective H.P., which are definitely tied to the speed. The best locomotives, including once again the S 10_1, but not the large compound class 02 engines at that speed, take much less than 5 400 kgr./cal. (21 430 B.T.U.) per I.H.P.-hour. One of the class 03 locomotives tested (03030) gave 4 050 kgr./cal. (16 070 B.T.

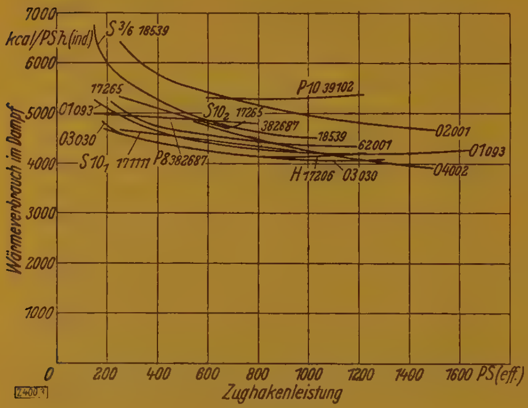

Fig. 3. — Heat expended in the steam in kgr./cal. per I.H.P.-hour in terms of the drawbar horse-power. The heat expended is calculated at the feed water heater outlet. Speed 100 km. (62 miles) an hour.

Note: Wärmeverbrauch im Dampf = heat expenditure in the steam.

U.) per I.H.P.-hour, probably owing to the rather low value of η obtained (see below), and the other (03001), 4190 kgr./cal. (16 630 B.T.U.) per I.H.P.-hour. The ultra-high-pressure locomotive, H 17206, with 4 150 kgr./cal. (16 290 B.T.U.) per I.H.P.-hour is hardly better than the 01 locomotives. The new express locomotives with average pressure taking 3 900 kgr./cal. (15 480 B.T.U.) per I.H.P.-hour are better than any. The 25-kgr. (355.6 lb. per sq. inch) pressure goods locomotive, not shown on the figure owing to its different speed, with 3 610 kgr./cal. (14 325 B.T.U.) per I.H.P.-hour, gave still better results. What is more important, however, from an operating point of view, is that the consumption of the standard locomotives is definitely less than that of the old 12 to 14 kgr. (170.7 to 199.0 lb. per sq. inch) pressure locomotives with a lower steam temperature. The consumption of the P 8 and S 10_2 locomotives is not much below 5 000 kgr./cal. (19 840 B.T.U.) per I.H.P.-hour and that of the P 10 locomotives is not even as low as this figure.

As far as the preponderating economical factor is concerned, the consumption of coal per effective H.P.-hour, including therefore the efficiency of the boiler, its specific value at 100 km. (62 miles) an hour, usually slightly exceeds 1.3 kgr. (2.87 lb.) of coal per drawbar horse-power; the 01 locomotive alone is below with 1.27 kgr. (2.80 lb.) per drawbar H.P.-hour. The 04 locomotive (pressure 25 kgr. = 355.6 lb. per sq. inch) only uses 1.05 kgr. (2.32 lb.) per H.P.-hour. These figures are for the usual coal of a minimum calorific value h_u = 7 000 kgr./cal. per kgr. (12 600 B.T.U. per lb.).

If these figures are compared with stationary engine results (the consumption at the drawbar would be comparable for example to the « horse-power at the pit » of winding engines) the above figures must be multiplied by η = 0.7 for 100 km. (62 miles) an hour (see below) and then becomes quite different, namely 0.9 and 0.72 kgr. (1.98 and 1.59 lb.) per I.H.P.-hour.

In the case of the 25-kgr. (355.6 lb. per sq. inch) pressure goods locomotive, which is very good as regards evaporation, the coal used falls to 0.67 kgr. (1.47 lb.) per I.H.P.-hour at 60 km. (37.3 miles) an hour. As with the 01 and 03 express locomotives, there are working zones away from the 100-km. (62 miles) an hour speed and the maximum capacity of the boiler, in

which the corresponding coal consumption falls below 0.9 to 0.87 and 0.85 kgr. (1.98, 1.91 and 1.85 lb.) per I.H.P.-hour.

If we take the coal consumption when the boiler is working to its maximum capacity (« boiler limit ») in terms of the speed (fig. 4), we again find it is sometimes less than 1 kgr. (2.20 lb.) per drawbar H.P.-hour. For example it is 0.97 kgr. (2.13 lb.) at 60 km. (37.3 miles) an hour for the 0.2 locomotives; 0.94 kgr. (2.07 lb.) at 80 km. (49.7 miles) for the 25-kgr. (355.6 lb.) pressure locomotive, and only 0.84 kgr. (1.85 lb.) for the 25-kgr. (355.6 lb.) pressure goods

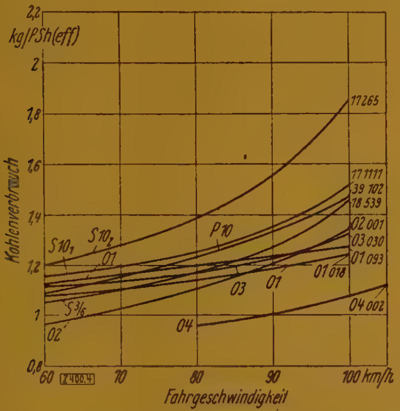

Fig. 4. — Coal consumption at the « boiler limit » (57 kgr. steam per m² = 11.67 lb. per foot per hour) in kgr. per effective drawbar horse-power-hour, at different train speeds.

Note : Fahrgeschwindigkeit = train speed. Kohlenverbrauch = coal consumption.

and passenger locomotive. The curves for the compound locomotive rise definitely more sharply; they turn slightly upwards when the speed exceeds 90 km. (56 miles) an hour, except in the case of the $S10_2$ locomotive, which is not too efficient because of its excessively large cylinders and gave the same results when working simple. The fact is that, at low speeds, the recent 02 and S 3/6 compounds, with their better boiler efficiency, are the best of the present locomotives. The two 01 locomotives of different manufacture slightly differ in their cylinders and boilers and also in the tolerances allowed. The 25-kgr. (355.6 lb.) locomotives have given particularly good results, never equalled before.

As regards the ultimate development of the normal type, it may be questioned whether the superheat temperature should not be raised in the case of the 25-kgr. (355.6 lb.) pressure boiler, so as to make sure that, with the prolonged expansion in the compound locomotive, the steam does not reach the saturation zone, earlier tests having demonstrated the value of the exhaust steam remaining superheated [12]. Another question, in using simple expansion to avoid compounding, is whether equally favourable figures can be obtained by using lower steam pressures, such as 20 kgr. (284.4 lb.), but with very high superheat. The resulting advantage would be a lower mean cylinder (piston rings) temperature than in the high-pressure cylinder of a compound engine and, in view of the difficulties still experienced with high pressure, a less severe specification for boiler materials. This would appear to be a very good solution, especially having regard to the published consumption figures [13] of some recent 20-kgr. (284.4 lb.) pressure French locomotives. However this is not in any way an objection to the higher pressures also tested in Germany.

Multi-cylinder locomotives and compound locomotives.

The position of the two problems, to some extent related to one another, of locomotives with more than two cylinders and compound locomotives is that,

(12) H. NORDMANN, *Organ für die Fortschritte des Einsenbahnwesens*, vol. 67 (1930), p. 241.

(13) See, amongst others, M. A. PARMANTIER, *Revue Générale des Chemins de fer*, vol. 51 (1932), second half, p. 187.

in the absence — or perhaps because of — further test work, no clear boundary line can be drawn between systems with two or more cylinders and between simple or double expansion.

A large number of cylinders will be considered when the tractive effort becomes so great that the pressure exerted by the two pistons is considered too great for two crank pins. When the number of revolutions per minute is very high, there will be a tendency to think that a two-cylinder motion may set up excessive disturbing forces, that is to say the running will not be smooth enough and the vibrations of the locomotive too violent. In this event a three-cylinder motion with the three cranks at 120°, or a four-cylinder mechanism with the four cranks at 90°, well balanced and practically free from disturbing movements, is thought necessary.

The first limiting condition, considered by itself, is undoubtedly very high, as is shown by the great tractive efforts corresponding to an adhesive weight of 95 to 98 t. (93.5 to 96.5 Engl. tons) of the class 95 (T 20) and 43 two-cylinder locomotives. The force exerted on the pistons — and consequently the horizontal thrust on the crank pins — of large cylinders of 700 and 720 mm. (27 1/2 and 28 3/8 inches) diameter reaches 53 to 56 t. (52.2 to 55.1 Engl. tons) when the boiler pressure is 14 kgr./cm^2 (199.1 lb. per sq. inch).

The two-cylinder type of the class 43 engine has been given preference over the three-cylinder class 44 engine, of which an equal number were originally built; it is simpler and also more economical as regards steam consumption. In many cases, however, the multi-cylinder design may be preferred because of the disturbing movements of the heavy rods. An example of this is found in the new class 85 locomotive for the Höllental line [14].

(14) See E. Wohllebe. *Z. VDI*, vol. 77 (1933), p. 904.

In this case, the problem consisted in designing a locomotive with a high tractive effort, chiefly for working a service mainly passenger, over a heavy gradient up to then worked by rack. As this was a case of important tourist traffic and road motor competition had to be met, the service for a great distance running alongside the railway, great comfort was therefore to be provided, and this meant that any vibrations transmitted to the leading vehicles which might be felt by the passengers as irritating rhythmic parasitic movements — of little amplitude, it is true — had to be avoided.

At an earlier date, diagrams of the tangential pressures for two — or three — cylinder motions, based on actual steam indicator cards of the class 43 (two-cylinder simple) and class 44 (three-cylinder simple) engines, had been studied. The greater uniformity resulting from the slightly greater average tractive effort for the same maximum values of the tractive effort, hindering hunting in the same degree, at once led as a first condition to the use of the three-cylinder engine. The dynamometer-car diagrams also demonstrated the small variations of tractive effort as compared with the violent oscillations of the T 20 class.

The specific steam consumption of the three-cylinder engine is only slightly higher, the loss of power, for the same boiler output, is so small that it can be made good by a slightly increased evaporation, and finally the maximum tractive effort is definitely greater thanks to the larger adhesive weight and the uniform tangential effort.

Now let us consider another aspect of the problem. The 03 two-cylinder locomotive was primarily intended for a speed of 120 km. (74.6 miles) an hour; besides, this speed corresponding to 320 r.p.m. was said to represent the speed limit of incompletely balanced motions. For higher rotational speeds, three — or four — cylinder engines were

thought essential so as to ensure that the vibrations, which increase as the square of the speed, did not make the engine unpleasant to ride on and did not reduce the time between repairs. However, as the fast runs between Berlin and Hamburg discussed later on showed, the 63 type locomotive, when well maintained and especially when care is taken to prevent play in the brasses, rode very smoothly at 140 km. (87 miles) an hour.

We have, therefore, one instance in which the two-cylinder arrangement has already been given up for slow speed work attendant, it is true, upon high tractive efforts, and consequently heavy motion parts, whereas in another, the two-cylinder motion has shown itself much more suitable than was formerly thought for high speeds with lower tractive efforts engines really heavy in themselves. The choice between two and more cylinders is, therefore, more difficult to make, but this, in certain circumstances, may make it easier ultimately to decide the design by eliminating so-called essential considerations.

Compounding is also bound up to some extent in the question of the number of cylinders because, with rare exceptions, no one now thinks of building two-cylinder compounds with superheated steam. One possible exception would be light locomotives using high pressures such as 25 kgr. (335.6 lb. per sq. inch), as sufficient expansion of such high-pressure steam cannot be obtained in one cylinder and the low power does not yet justify the use of 4 cylinders. On the other hand, compounding is thought to be attractive in connection with high pressures and speeds, when a multi-cylinder engine is used to reduce the thrust on the crank pins or to get really good riding. This brings in new and important factors.

In the theoretically perfect engine, compounding shows no heat saving: in practice, however, with saturated steam engines the losses through cooling are reduced very considerably, especially the condensation at admission. Then too, leakage and heat lost through the walls and piston are reduced when the pressure and temperature drops are in stages in two cylinders arranged in tandem. The resulting saving varied in value, but existed under *all* working conditions. The application of compounding to highly superheated steam ought necessarily to have reduced the saving considerably, since there was no condensation at admission. In spite of this, a saving under all working conditions was still claimed.

The proof that this was not so was first brought out in tests made some five years ago on the two standard types of locomotive, the 01 and 02, at a speed of 80 km. (49.7 miles) an hour. Up to medium powers, the simple-expansion locomotive was the more economical, and only at high powers did the compound locomotive show the modest saving of 3.5 %. We had still to see what happened at other usual speeds such as 60 and 100 km. (37.3 and 62 miles) an hour. Other urgent tests had to be made, however, in the meantime, and only recently as a result of new tests of the 02 locomotive at all powers and speeds in comparison with the 01 locomotive on which full data was available, have we been able to answer this question definitely. In addition, the complete data available on the rather lighter standard two-cylinder class 03 locomotive, and on the 4-cylinder compound S 3/6 locomotive with almost identical boilers, gave us a second comparison between the thermal properties of simple and double expansion.

Indeed, power, as well as speed, was found to affect the positive or negative saving due to compounding. If we again consider the recent 01 and 02 locomotives (fig. 5) practically identical, moreover, the slight differences in the boiler being eliminated by converting the steam consumption figures into kgr./

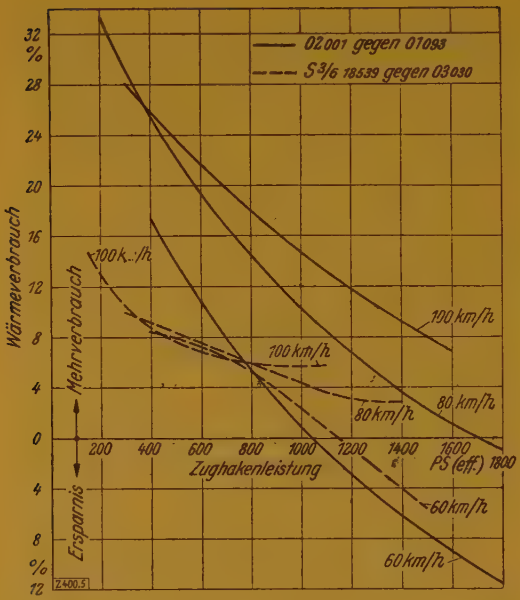

Fig. 5. — Differences in the heat expended per effective horse-power-hour by the 02 and S 3/6 compound locomotives and the 01 and 03 simple-expansion locomotives at different train speeds, in terms of the drawbar horse-power.

Explanation of German terms:

Gegen = against. — Ersparnis = lower consumption. — Mehrverbrauch = higher consumption. — Zughakenleistung = drawbar horse-power.

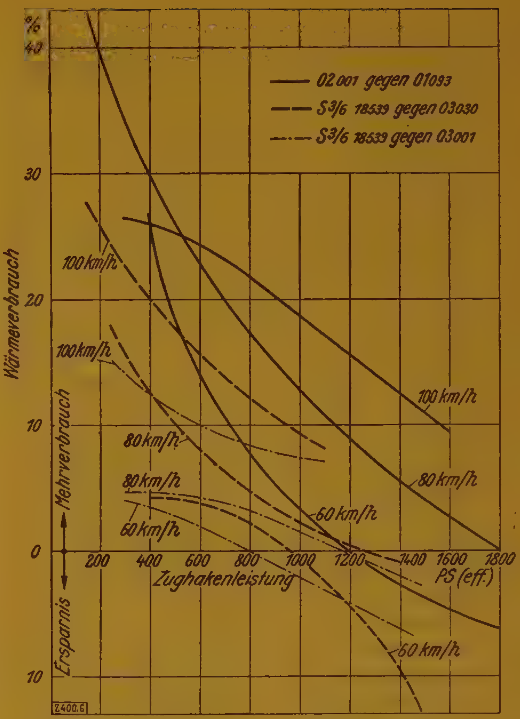

Fig. 6. — Difference in heat used per I.H.P.-hour by the 02 and S 3/6 compound, and the 01 and 03 simple-expansion locomotives at different train speeds, in terms of the drawbar horse-power.

The curves show the increased or reduced heat used in kgr./cal. per I.H.P.-hour as a percentage.

calories per effective H.P.-hour, so that these consumptions are expressed in pure heat values, we find at 60 km. (37.3 miles) an hour, a zone above 1 050 effective or 1 200 indicated H.P. in which the compound engine is more economical. At lower powers, on the other hand, it uses up about 20 % more, ignoring very small powers out of proportion to the dimensions of the locomotive.

At 80 km. (49.7 miles) an hour the compound engine ceases to use more steam at 1 700 effective H.P., that is to say when the « boiler limit » is reached, and at 100 km. (62 miles) an hour, the compound engine is much *less economical throughout the range of powers.*

In principle, the same thing occurs with the 03 and S 3/6 locomotives, which have the same heating surface and steam pressure, but a difference in the superheat, that of the S 3/6 being 20 to 25° C (36 to 45° F.) lower. This leads us again to express the energy consumed as a pure heat value in kgr./calories per effective H.P.-hour. Here again at 60 km. (37.3 miles) an hour, there are zones above 1 150 effective H.P. in which heat is saved. On the other hand, the consumptions are appreciably higher at low powers. Even at 80 km. (49.7 miles) an hour, the compound engine is unable, for

the higher effective powers, to show the same economy as the simple-expansion locomotive.

The indicated consumption figures represented in figure 6, in which a second 03 locomotive is shown besides No. 03030, only changes the result in that, at 80 km. (49.7 miles) an hour, the compound is still slightly better at maximum boiler output. At 100 km. (62 miles) an hour, however, the differences are too wide everywhere to be made good by equalising the superheat. The somewhat peculiar form of the curves is no doubt due to the tolerances in making measurements.

If we examine diagram i-ϕ, we notice the remarkable fact that the lower scale of temperature drop, the point of exhaust i_2, is almost the same, at low powers, with the simple and the compound engine. As the power rises, the exhaust steam from the simple-expansion engine takes a greater and greater value; the heat value i_2 in the exhaust steam from the compound engine also increases, it is true, but more slowly. Consequently at a given speed, the loss of heat in the exhaust increases with the power at a higher rate with the simple engine, so that the compound is sometimes the better. This is not a final explanation, as there seems to be no reason why it should be so; but this clearly presents the facts.

We will conclude therefore that, at least on big engines working at a pressure of 16 kgr. (227.6 lb.), only at mean speeds, at high powers, is there a small zone in which the steam consumption is more advantageous, but this improvement disappears entirely at high speeds. On the whole, in service the simple engine is consequently better, especially when high speeds are considered, in view of which the four-cylinder motion was provided. An improvement is only possible by re-designing the steam passages feeding the cylinders so as to make them straight and of large cross-sectional area.

Besides, this is shown in the power characteristics — $N = f(V)$ or $N_i = \varphi(V)$ — for a given continuous boiler output (figs. 7 and 8). The ma-

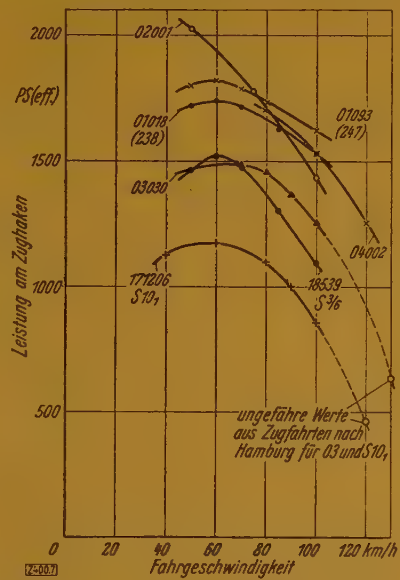

Fig. 7. — Drawbar horse-power (effective) of various express locomotives, at full boiler output (57 kgr. per m² = 11.67 lb. per sq. foot per hour) at different train speeds.

Note: Ungefähre Werte... = approximate values obtained from train runs to Hamburg with the 03 and S 10 engines.

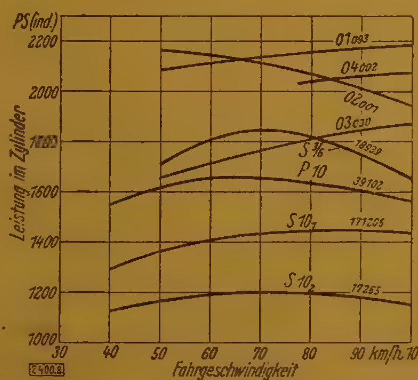

Fig. 8. — Cylinder horse-power (indicated) at full boiler output at different train speeds.

ximum power of the big compound engines at 16-kgr. (227 lb.) pressure always corresponds to a rather low optimum speed (i.e. that at N_{max}); the power curves drop sooner and then show, over the same speed abscissa, less horse power than a comparable simple engine. In the case of the N_e curve for drawbar horse-power, there is no longer a maximum with, for example, the 02 locomotive; the curve falls from the beginning, as 50 km. (31 miles) also represents the speed of adhesion. If N_i be taken as the value most correctly representing the steam action in the cylinder (fig. 8), the optimum speeds of the 02 and S 3/6 locomotives are only 50 and 70 km. (31 and 43.5 miles) an hour, whereas that of the 01 and 03 simple-expansion locomotives clearly still exceed 100 km. (62 miles) an hour.

It must therefore be admitted — not perhaps without regret — that the usual and long-held opinion that in all cases the 4-cylinder compound engine is the ideal steam locomotive for express trains is unjustified. From a purely mechanical point of view, this design, thanks to its well balanced motion, is undoubtedly a free running engine, but from the standpoint of the use of the steam, it does not succeed at high speeds as well as the simple-expansion engine in getting rid of the steam which has done equal work in cylinders arranged in series. As there are more points where wire-drawing occurs, this must be corrected by making the passages larger than on simple engines; furthermore the steam must flow in a straight line. Now, these conditions are not easy to fulfil in the cylinder blocks of our large engines, in the space available. The good results given by the old S 10 engines are evidently due to the fact that only small cylinders had to be lodged in the available space, and this made it possible to provide larger and straighter steam passages. This is also the main reason why the large 04 locomotive also has its optimum speed at 100 km. (62 miles) and over per hour. Indeed, with the high pressure of 25 kgr. (355.6 lb.), the cylinders are relatively small. With higher numbers of revolutions per minute, we would say for future express locomotives, the fact that the passage of the steam through the cylinders is better with *simple expansion* will have to be seriously taken into account. Besides, there is no reason why a well balanced three-cylinder or four-cylinder engine should not be used [15]. A compound engine could become inferior at the very moment at which, at the high speed shown by the *product* of the train resistance by the speed, it has most need of high power. Contrariwise, a compound goods engine can be advantageous for working over long gradients because the high power always required to get fuel economy from the compound engine is obtained in this case by the high tractive effort combined with a moderate speed. The simple-expansion engine, on the other hand, not only gives in most cases the most economical engine but in all cases the most simple.

Efficiency.

In view of the explanations given earlier [16], the mechanical efficiency — η = the drawbar power × the cylinder power — would not need any further comment if it were only to give particulars of its changes. At low speeds, η, shown on the diagram above the drawbar horse-power, is a curve with clearly defined changes of curvature, like a magnetisation curve (fig. 9). At high speeds, with considerable air resistance, the change of curvature is less pronounced and more closely resembles a flattened

(15) In the meantime, the final design of express engine chosen was the three-cylinder type.

(16) H. Nordmann, *Org. Fortsch. Eisenbahnwes.*, vol. 67 (1930), p. 245.

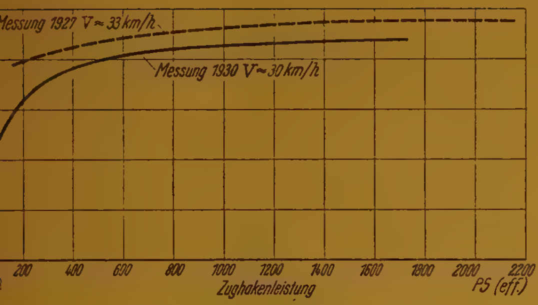

Fig. 9. — Mechanical efficiency, at low speed, of 2-10-0 goods locomotive No. 43001.

The lower and more accurate curve is the result of modern indicator practice. The drawbar power relates to level sections of line.

Note : Messung = measurement

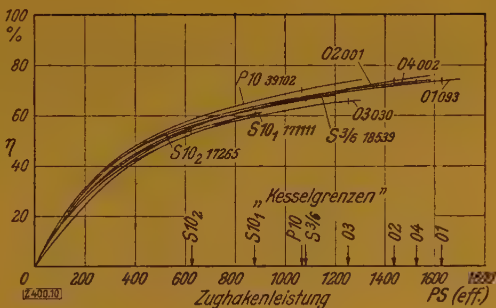

Fig. 10. — Mechanical efficiency of various express locomotives at 100 km. (62 miles) an hour.

The drawbar horse-power relates to level sections of line.

arc (fig. 10). In connection with figure 9, modern technical improvements in indicators, by reducing the errors in the instruments, must be mentioned. We have already mentioned ([16]) that $\eta = 0.95$ seems hardly possible for a ten-coupled goods locomotive and the new final value of 0.88 strikingly confirms this opinion. In figure 10, the general agreement of most of the locomotives at 100 km. (62 miles) an hour will be observed. The eight-coupled P 10, with the smallest wheels, precisely heads the list because it was tested before the indicators were improved. The old method of taking the diagram by means of indicators with large inertia masses and a cord which stretched gave, at a high number of revolutions, slightly too high values of η. Lokomotive 03030 falls slightly below the group; on the other hand, engine 03001 (not shown in figure 10) lies within the compact group of curves. As the curves η of 03030 and of 03001 quite coincide at 60 km. (37.3 miles) an hour and almost do so at 80 km. (49.7 miles) and at high powers, the slight difference shown by 03030 at 100 km. (62 miles) an hour is doubtless accidental, as there is no reason why it should be less favourable than the other six-coupled express engine. If the S 3/6 and the 04002, in spite of being 4-cylinder engines, are not inferior to the simple-expansion locomotives, this is due to the compression being less in consequence of the longer cut-offs in the various cylinders. It is found, moreover, that as the power rises with the full output of the boiler, the value of η becomes greater. The air resistance, whilst remaining more or less steady with the big engines, is less felt by the rounded off contours.

Ignoring the really too low position of the curve for 03030, this value for the large locomotives, at 100 km. (62 miles) an hour is between 67 % and 74 %, so that 70 % can be taken as the average value in round numbers.

We would like to point out that this is the first time that the range of powers corresponding to 120 km. (74.6 miles) an hour has been methodically investigated for a medium-pressure locomotive, in conjunction with the brake locomotive. We obtained the flatter η curve and found for it a value of 0.61 at full boiler output. This speed — or rather the corresponding number of revolutions, seeing the express engines compared have with one exception the same wheel diameter, i.e. 2 m. (6 ft. 6 3/4 in.) — appears to be the limit of tolerable accuracy of the indicator : the endeavours made to take indicator cards

systematically during fast runs on the 03 locomotive at 135 km. (83.9 miles) an hour have failed so far through the thin steel cables (substituted for the old cords) breaking frequently.

Using an approximative method, the S 10 and 03 locomotives at 120 and 130 km. (74.6 and 80.8 miles) an hour have been considered as having η values equal to 1/3 in round figures (fig. 11);

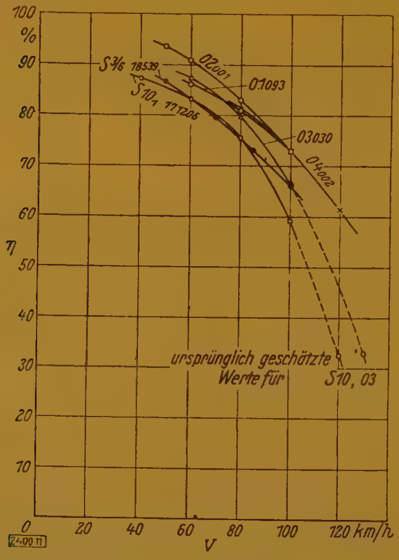

Fig. 11. — Mechanical efficiency at full boiler output, in terms of the speed V.

Note: Ursprünglich geschätzte Werte für... = values originally assumed for...

and the relative values at high speeds are precisely those which, in view of present high-speed tendencies, induced us to investigate the efficiency in the true locomotive meaning. It is true that the fast runs with the S 10 locomotive and three corridor coaches, at a speed which reached 140 km. (87 miles) an hour at times, were made at higher boiler outputs and, therefore, a greater value of η. The results from the 03030 engine were slightly bettered by the recently known results of the fast runs which already gave, with a much smaller boiler output (< 57 kgr. per m² = 11.7 lb. per sq. foot per hour), the assumed power used in figure 7. The value of η of the 03 locomotive at its « boiler limit » then appears to be slightly higher. We will return to this case later on; some prudence in forming any judgment is needed for the reason that the working conditions were not perfectly constant because of various circumstances (reduced maximum speed in the suburban area, and through Wittenberge station, and relaying slacks), as in fact they scarcely ever can be on such a length (287 km. = 178.3 miles).

The efficiency at 130 km. (80.8 miles) an hour is nonetheless 0.40 or even 0.45 — the exact value can only be learnt when indicator diagrams can be taken at high rotational speeds — which values at first sight appear low.

It should be pointed out that *at high speeds and, therefore, with high air resistance,* no such sharp distinction can *be made between the locomotive and the train.* It must be remembered that the locomotive removes the head-on resistance from the train, and it is solely due to this *protection* that steel corridor coaches have — eddies being ignored — the small equivalent area of about 1.50 m² (16.14 sq. feet) as compared with 12 to 14 m² (129.1 to 150.6 sq. feet) of the locomotive ([17]). From an economic point of view, therefore, so as not to be unfair to the locomotive, we should adopt in preference the notion of horse-power per place offered.

This does not excuse us from endeavouring to improve the value η logically and exactly defined.

Hence the modern tendency to give the outside of the locomotive a streamlined form. Borsig is responsible for much initiative in this direction, in con-

(17) See SAUTHOFF, « Die Bewegungswiderstände von Eisenbahnwagen (Resistances to motion of railway vehicles). Berlin, 1933; O. VOGELPOHL, *Z. VDI*, vol. 78 (1934). No. 5, p. 159 (also *Bulletin of the Railway Congress*, September 1934, p. 939).

nection with the locomotive designed for speeds of 150 km. (93.2 miles) an hour. The design was based on the results of trials in the wind flume of the Berlin Higher Technical School, on models to a scale of 1 : 33 1/3, which was rather small, it is true, but the maximum the wind tunnel could deal with. Owing to the small dimensions of the model, the parts causing the eddy currents set up round the engine, such as the motion, pumps, etc., could not be reproduced, and were, in fact, left out. The tests, this time with 1 : 20 models supplied by Borsig, which were faithful reproductions with all fittings offering resistance to the air, such as hoods over the spectacle glasses, lamps, by-pass valves, etc., were repeated in the 1933 spring on behalf of the Reichsbahn, in the wind flume at Göttingen. Wind speeds of 30, 40 and 50 m. (98.4, 131.3 and 164 feet) per second were used to obtain three points for the approximately parabolic curve representing the air resistance relatively to the speed. These tests seem so instructive and important that we hope to write a special article on them. It must be mentioned briefly, however, that the air resistance naturally attains its highest values for the ordinary design of locomotive, even with slight variations such as with an ordinary or an ellipsoidal smoke box door, a straight or tapered driver's cab. Then, at a *much* lower level, we find the covered-in locomotive with the cab at the rear as usual, but given a streamlined shape resembling that of the fast rail motor coach, and with its motion hidden by a large or small petticoat, etc. Finally the lowest position is that of the tank engine with the cab at the front end, and completely enclosed. At 150 km. (93.2 miles) an hour, the difference between the two extreme forms in the power absorbed by air resistance in dead calm is 750 H.P., so that even the intermediate forms show a considerable saving. At the same time special tests have been initiated to ascertain the best form of side screens for high speeds. It was found that the best arrangement is to fit them at the side of the chimney.

Fast runs made by steam locomotives.

Some comments on the 1933 fast runs between Berlin and Hamburg, the programme of which differed from that for 1932, may be of interest. At that time the trains were heavy summer trains, worked by 01 locomotives, the trains weighing as much as 600 t. (590 Engl. tons), at speeds up to 120 km. (74.6 miles) an hour on the level, at which speed the locomotive proved able to run near the usual boiler limit (for an efficiency of 60 %) with 600 t. (590 Engl. tons) up to 115 km. (71.5 miles) an hour, and with 500 t. (492 Engl. tons) up to 120 km. (74.6 Engl. tons) an hour.

In the case of the 04 locomotive, 120 km. (74.6 miles) an hour was worked for the first time as a trial speed with the brake locomotive. The conditions for an ordinary train in place of the fast rail cars had then to be investigated, of course in the same running time or little more : this meant a working speed of 130 km. (80.8 miles) an hour on the level.

Now, this programme was widened and made more useful by investigating the possibility of using ordinary locomotives for hauling lighter trains at very high speeds.

The classes of locomotive selected were the S 10_1 and the 03. The S 10_1 locomotive was found to be too weak. It is true, the engine maintained, thanks to an exceptionally high boiler output, a speed of 140 km. (87 miles) an hour for some time, with the dynamometer car and two corridor coaches (touching 152 km. (94.5 miles) an hour on the Hanover line during the tests on the running of light coaches for through trains, three in number). The boiler never flagged, but the big ends ran hot frequently through the excessive pres-

sures on the crank pins so that a reliable service could not be guaranteed if worked by the S 10 engines, although they worked well normally, though of too low power.

On the other hand, the 03 locomotive did the work very well. It is true that certain defects revealed themselves during the first runs though using an engine in an average state of repair. Small amounts of play in the axle box bearings and the rod bushes, which were harmless up to 110 km. (68.4 miles) an hour, already caused difficulties at 130 to 140 km. (80.8 to 87 miles) an hour. This proved that one of the conditions for success was bearings in good order — careful attention to maintenance. After setting up the brasses, locomotive 03030 ran without further trouble. One run with locomotive 03038 had to be stopped owing to oil being lost out of the main coupling rod oil well, the result of the cover bolts breaking. A defective right hand big end brass on locomotive 03073 was due to an old bearing which had run 140 000 km. (87 000 miles).

Defects of this kind can be avoided by good maintenance of the bearings, and by taking care that the actual time in service of the bearing is not excessive. Apart from these two fortuitous casualties, the other 34 runs of the three 03 locomotives were more satisfactory. The weight of train hauled was 153 t. (150.5 Engl. tons), on the first four runs, and then increased to 200 t. (196.6 Engl. tons). The weight was increased to 240 tonnes (236 Engl. tons) on five runs. In most cases the dynamometer car was attached to the locomotive. In a few cases, the consumption of water was not measured, i.e. the evaporation per square foot of heating surface was not ascertained.

Owing to the many service slacks (summer relaying) and the inclusion or exclusion of the Berlin-Nauen suburban line on which the steam train could not exceed 100 km. (62 miles) an hour, the average speeds differed widely and varied from 103.5 to 118.7 km. (64.3 to 73.7 miles) an hour. The slower speed was over a particularly long relaying section including a stop, and a short distance on the wrong road. As a comparison, we may mention that the fast rail motor coach unit had, according to the 1933-34 winter timetable, an average booked speed of 124 km. (77.1 miles) an hour. The usual running speed was 130 to 135 km. (80.8 to 83.9 miles) an hour. The maximum speeds were 135 to 144 km. (83.9 to 89.5 miles) an hour; it was 139 km. (86.4 miles) for the 240-t. (236 Engl. tons) train. The simple expansion locomotive ran very steadily at these speeds. A noticeable feature was that on none of the runs was the usual boiler limit (57 kgr. per m^2 = 11.67 lb. per sq. foot) of steam per hour even approached. The engine therefore was never forced. The steam output was usually 40 to 50 kgr. per m^2 (8.19 to 10.24 lb. per sq. inch) per hour. The difference in these figures was due to the different speeds, the number of accelerations and the atmospheric conditions.

The drawbar horse-power varied with the 200-t. train from 547 to 700 H.P., but most usually was about 600 H.P. Even at 700 H.P., the boiler limit was far from being reached, seeing that the steam produced was less than 51.6 kgr. per m^2 (10.57 lb. per sq. foot) per hour. As at high revolution numbers the power would perhaps remain, within the boiler limit, below the optimum value of 1 900 I.H.P. of the 03 locomotive, but as the boiler limit and therefore 1 900 H.P. were not nearly reached, the efficiency η for average speeds with open regulator is certainly greater than 700 : 1 900 = 0.36, as already mentioned above. The best we could admit is $\frac{51.6}{57} \times 1\,900$ = 1 720 I.H.P., and therefore the best value of $\eta \pm 700 : 1\,720 = 0.407$. With

a steam consumption of 15 kgr. (33.07 lb.) in round numbers per effective H.P.-hour, the optimum consumption would be 0.407 × 15 = 6.1 kgr. (13.44 lb.) per I.H.P., a very good value, so that high numbers of revolutions do not increase the steam consumption.

In a number of cases the acceleration period with the 200-t. train was more closely gone into. Figure 12 shows 3 starts taken from the dynamometer-car records, a start from rest, and two acceleration periods from 50 km. (31 miles) an hour, after running over sections at reduced speed, which are connected to the point representing 50 km. (31 miles) an hour on the first curve. We see that 130 km. (80.8 miles) an hour is reached in 330 to 400 seconds after running 8 to 10.5 km. (5 to 6.5 miles). The zone of speeds over 100 km. (62 miles) an hour was reached in 200 to 240 seconds after running 3.5 to 4.2 km. (2.17 to 2.61 miles).

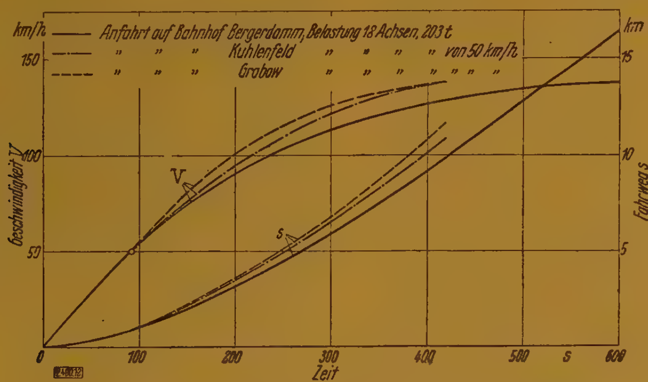

Fig. 12. — Starting distances *s* and starting speed V, of a 03 simple-expansion locomotive, in terms of time.

Note: Anfahrt auf Bahnhof... = starting from... station. — Von = starting from... — Zeit = time. — Fahrweg = distance run.

The deductions to be made from the total length of the line for the acceleration period are therefore very small for heavy corridor trains with few stops. And in the case of level lines, most of the line is always available for high-speed running.

No one would dream of detracting from that wonderful piece of engineering, the high-speed rail motor coach, but in spite of the very ardent campaign waged in its favour, it will be well to underline once more the fact that an ordinary simple-expansion express locomotive can operate very fast trains very satisfactorily. The old, yet ever young, steam locomotive which has for so long covered the work and still does the major part, should not be relegated to the back ground, but instead should be called upon to do its best on a strict basis of equality [18].

[18] Though the press has not mentioned it, the 1933/34 winter service includes the two regular fast steam trains Nos. 23/24 running between Berlin and Altona at an overall speed of 110 km. (68.4 miles) an hour.

[621. 33 & 656. 256]

Ground detector for A.-C. track circuits on electrified lines,

By CHARLES F. HOWE, Jr.,

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(Railway Signaling.)

For years, signal maintainers have employed the principle of magnetic induction in detecting short-circuits on track circuits, as this principle is simple and efficient. A closed coil of wire, preferably triangular in shape, in series with a pair of head phones, picks up the signal induced from the 25 or 60-cycle track circuits, and enables the maintainer to locate quickly a leak from one rail to the other. To the writer's knowledge this mehod of detecting leaks has heretofore been unsuccessful on rapid-transit lines, or any railroad using propulsion current, because of disturbances created by the propulsion current that tend to drown out the 25- or 60-cycle track-circuit signals.

It is the purpose of this article to explain the design of a detector that will locate a short on a track circuit, for use on railroads employing direct current as motive power. The theory that has to be taken into consideration in this design is relatively simple, and after studying this article any signal department, not necessarily elaborately equipped, should be able to construct its own detector. To make the explanation more easily understood, the design of a detector that has actually been tested and put in service will be followed throughout.

When a pair of head phones is connected to an exploring coil, and the coil held over the rail, the track-circuit current flowing in the rails induces a voltage in the exploring coil, which produces a current in the coil and the head phones. This current causes a low hum in the head phones. The propulsion current flowing in the return rail also induces a voltage in the exploring coil, and this voltage produces a current that also causes a hum in the head phones, but of a different pitch that drowns out the hum caused by the track-circuit current. Thus the current flowing through the exploring coil and the head phones has two components, one due to the propulsion current and the other due to the track-circuit current. If it is possible to eliminate the component due to the propulsion current and pass the component due to the track-circuit current, the exploring coil and head phones may be used as they are on steam railroads to detect leaks from one rail to the other.

Procedure in design.

Whether the propulsion current is obtained from synchronous converters, motor-generator sets, or mercury-arc rectifiers, there is the accompanying disturbance which interferes with the successful operation of the exploring coil and head phones. The propulsion current in this case is obtained from twelve-phase mercury-arc rectifiers. The supply for the rectifiers is obtained from transformers with a delta primary connection and a connection known as the quadruple zig-zag on the secondary. This connection gives a ripple frequency in the propulsion current of 1 080 cycles. The frequency of the track circuit source is 60 cycles, thus it is a simple matter to design a filter that will eliminate the 1 080 cycles and pass the 60 cycles.

However, the first consideration in the design is the exploring coil. A triangular form for the coil was used in order to get as much of the coil close to the rail as possible without making it bulky. A triangle 14 inches on a side was used

Detector set with the exploring coil.

as a form. By calculation and experimentation it was found that the best results were obtained by using No. 30 enamel wire, the optimum number of turns being 800. By applying a small 60-cycle voltage to the coil, and measuring the voltage, current and power consumed, it was an easy matter to determine the inductance and the effective resistance of the exploring coil. From the meter readings the impedance of the coil is determined; it is the voltage divided by the current.

$$Z = \frac{V}{I} \text{ ohms} \qquad (1)$$

The effective resistance is the power consumed divided by the square of the current.

$$R = \frac{P}{I^2} \text{ ohms} \qquad (2)$$

The inductive reactance is the square root of the difference of the squares of impedance and resistance,

$$X = \sqrt{Z^2 - R^2} \text{ ohms} \qquad (3)$$

The inductance of the coil is the inductive reactance divided by 6.28 times the frequency,

$$L = \frac{X}{6.28\, f} \text{ henries} \qquad (4)$$

wherein L is the inductance in henries and f is the frequency of the applied voltage. The inductance of the coil in this case was found to be 0.200 henries.

Before going on with the design it is best to give a short discussion of resonant circuits, for they play an integral part in the design of this detector. If to a series circuit consisting of resistance, inductance and capacitance, a constant voltage of changing frequency be applied, the current that flows will depend upon the frequency of the applied voltage. At low frequency the capacitive reactance is large and the inductive reactance is small. At high frequency the reverse is true; the capacitive reactance is small and the inductive reactance is large. Between these two extremes there is a frequency, called the resonant frequency, at which the capacitive and inductive reactances are equal and consequently neutralize each other. This leaves only the resistance of the circuit to oppose the flow of the current. Thus, at series resonance the current is at a maximum. In a parallel circuit, consisting of resistance and inductance in parallel with a capacitance, the resonant frequency is the point at which the inductive susceptance of the circuit is equal to the capacitive susceptance. They neutralize each other, leaving only the conductance of the circuit to oppose the flow of current. Since the conductance is usually small, the equivalent resistance of the circuit is very high, which results in only a small current flowing. Comparing series and parallel

resonant circuits it is found that at resonance the series circuit has a minimum impedance and consequently a maximum current flowing, while at resonance in the parallel circuit the impedance is a maximum and thus the current flowing is a minimum.

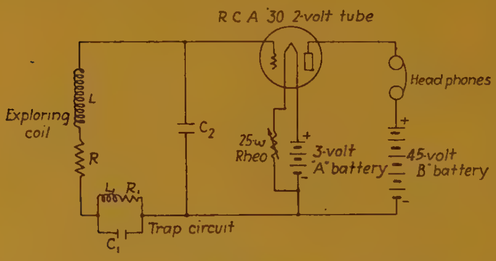


Fig. 1. — The circuit with one amplification stage.

If the resistance and inductance of a circuit be known, the circuit, whether it be a series or a parallel circuit, may be resonated for any frequency by combining the correct capacitance with the known inductance of the circuit. The resonant frequency is given by the formula,

$$f = \frac{159.2}{\sqrt{LC}} \text{ cycles per second} \qquad (5)$$

wherein f is the resonant frequency in cycles per second; L is the inductance in henries and C is the capacitance in microfarads. Equipped with this brief discussion of the effect of resonant circuits, it is possible to proceed with the design.

The next consideration in the design is the filter system, that will filter out the 1 080 cycles and pass the 60 cycles. A low-pass filter was used. This consisted of a trap circuit; a choke coil resonated in parallel with a condenser for 1 080 cycles, in series with the exploring coil (see fig. 1). From the preceding paragraphs it was indicated that parallel resonance offers maximum impedance to the current at the resonant frequency. Therefore, in the trap circuit there is offered to the propulsion-current component of current a maximum impedance which tends to choke out this component.

To pass the maximum amount of the track-circuit component of current, another condenser, C_2, was placed in series with the exploring coil and the trap circuit. This resonated the series circuit for 60 cycles, the frequency of the track-circuit component of current flowing in the exploring coil. Series resonance offers a minimum impedance to the current flowing. Therefore, because of series resonance at 60 cycles there is a maximum component of 60-cycle current flowing and, because of parallel resonance in the trap circuit at 1 080 cycles there is a minimum component of 1 080-cycle current flowing. The ratio of the amount of 60-cycle current to the amount of 1 080-cycle current flowing should at least be 10 to 1 for the circuit to be successful. In this case the ratio was approximately 34 to 1.

The inductance and the effective resistance of the choke coil were determined in a manner similar to the determination of the inductance of the exploring coil. The capacitance, C_1, required to give parallel resonance at 1 080 cycles may be determined by using formula (5). The choke-coil inductance in this case was 5.33 henries. The capacitance, C_1, required to resonate the circuit at 1 080 cycles is, by formula (5),

$$1080 = \frac{159.2}{\sqrt{5.33C_1}}, \text{ transposing and squaring}$$

$$C_1 = \frac{(159.2)^2}{5.33\,(1080)^2}$$

$$C_1 = 0.00408 \text{ microfarads}$$

To determine the capitance, C_2, required to resonate the series circuit at 60 cycles requires the determination of the equivalent reactance of the trap cir-

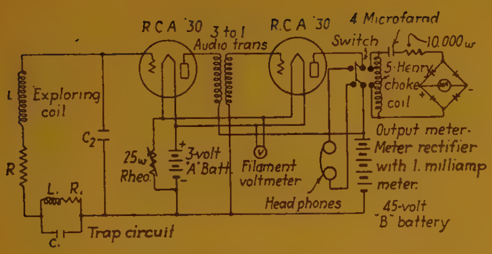


Fig. 2. — Two stages of amplification increase the indication.

cuit. The inductive susceptance of the trap circuit is given by the formula,

$$b_L = \frac{6.28\ L f}{(6.28\ L f)^2 + (R)^2} \text{ mhos} \tag{6}$$

wherein L is the inductance of the choke coil; f is the frequency of the current to be passed and R is the effective resistance of the choke coil. In this case the inductive susceptance of the trap circuit was, $b_L = 0.000319$ mhos. The capacitive susceptance of the trap circuit is given as,

$$b_c = \frac{6.28\ C f}{1\ 000\ 000} \text{ mhos} \tag{7}$$

wherein C is the capacitance of the trap circuit condenser and f is the frequency of the current to be passed. The capacitive susceptance in this case was found to be,

$$b_c = 0.000\ 001\ 62 \text{ mhos.}$$

The conductance of the trap circuit is,

$$g_L = \frac{R}{(6.28\ L f)^2 + (R)^2} \text{ mhos} \tag{8}$$

The conductance of the trap circuit was found to be,

$$g_L = 0.000\ 238 \text{ mhos.}$$

The total susceptance of the trap circuit is the difference between the inductive susceptance and the capacitive susceptance, or

$$b_t = b_L - b_c \text{ mhos} \tag{9}$$

$$b_t = 0.000\ 319 - 0.000\ 001\ 62 = 0.000\ 317 \text{ mhos.}$$

The equivalent inductive reactance of the trap circuit is given by the formula,

$$X_{eq} = \frac{b_t}{g_L^2 + b_t^2} \text{ ohms} \tag{10}$$

The values of the symbols used in this formula have been obtained from equations (8) and (9). Once the equivalent inductive reactance of the trap circuit is obtained it may be added to the inductive reactance of the exploring coil. The inductive reactance of the exploring coil is determined from,

$$X = 6.28\ L f \text{ ohms} \tag{11}$$

wherein L is the inductance of the exploring coil and f is the frequency of the component of current to be passed. In this case the equivalent inductive reactance of the trap circuit was found to be 2 060 ohms at 60 cycles and the inductive reactance of the exploring coil was found to be 76 ohms at 60 cycles. The total inductive reactance of the trap circuit and the exploring coil is the sum of these two, or X = 2 060 + 76 = 2 136 ohms. For series resonance at the frequency of the component of current to be passed, this inductive reactance must be balanced by a capacitive reactance. It is for this reason that the capacitance C_2 is added to the circuit. The required capacitance of C_2 may be determined by first substituting the above value of total inductive reactance in formula (4) to obtain the total inductance, L, then substituting this value of L in the formula,

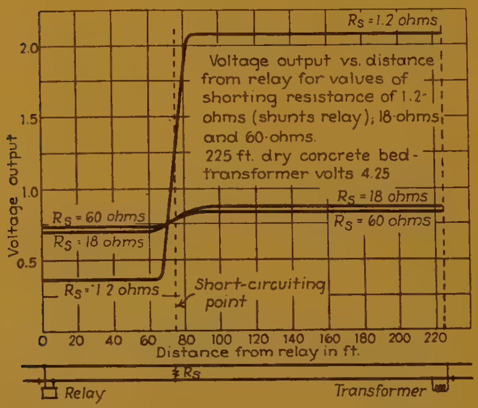
$$C = \frac{1\ 000\ 000}{39.44\ f^2\ L} \text{ microfarads}$$

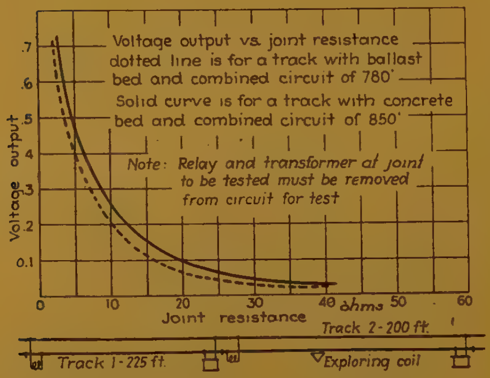
which is formula (5) transposed. The value of C_2 obtained in this manner was found to be 1.28 microfarads.

For a more complete description of the methods used in combining series and parallel circuits, it is suggested that the designer read that portion of an elementary, « Alternating Current, » textbook covering series and parallel circuits.

In order to increase the strength of the track-circuit signal so that the earphones would produce a louder note, the detector circuit was connected to a vacuum-tube amplifier circuit similar to those used in radio work. Connection is made to the grid of the tube as indicated in figure 1. This additional equipment greatly increases the sensitivity and usefulness of the set by making the track-circuit signal more audible.

Examination of the schematic drawings of the detector (figs. 1 and 2), will give the additional information covering the design of the detector. Conditions may not warrant the use of a second stage of amplification. It is best, before investing money in the parts required for a second stage of amplification, to make a test of the single stage of amplification (fig. 1). If the volume of track circuit component of current heard in the phones is sufficient, a second stage of amplification will not be required.





Figs. 3 and 4. — These curves show the performance of the detector.

Resume of design procedure.

In the case taken up here the ripple frequency of the propulsion current is 1 080 cycles and the track circuit supply is from a 60-cycle source. These two points are not general and undoubtedly differ for different railroads. Once they have been decided upon for any particular case the design of the detector follows the outline given. A choke coil of 5 to 10 henries is obtained and the inductance and resistance of the coil are determined. Then the capacitance required for parallel resonance at the frequency of the propulsion-current ripple is determined and paralleled with the choke coil. This completes the trap circuit. The equivalent reactance of the trap circuit is determined and added to the reactance of the exploring coil. The total inductive reactance of the exploring coil and the trap circuit is then balanced at the resonant frequency, the frequency of the track-circuit current, by a capacitance in series with the trap circuit and the exploring coil. This method insures a maximum pick-up from the track circuit and a minimum disturbance from the third rail or trolley. The filter system is then applied to the grid of an amplifier.

By inserting an output meter in the place of the phones (fig. 2), tests were made on track circuits with different shunting values of resistance between the rails. By plotting the output at different points in the track circuit it was found that there was a perceptibly higher output from the transformer end of the circuit to the shorting resistance than

there was between the shorting resistance and the relay end of the circuit, as might be expected. This was true for a value of shorting resistance that was 50 times greater than the value of resistance that would shunt out the track relay (fig. 3). The lower the value of shorting resistance, the better this detector works.

If staggered polarity is used on adjacent track sections, the relays in adjacent sections will drop away when the joint resistance drops below a certain point, 4 ohms in this case. Another test was made with the detector by removing the relay and transformer at one insulated joint, placing the exploring coil at any point along the rail and measuring the output for different values of joint resistance (fig. 4). With a great number of curves of the type shown in figure 4 of varying track conditions, lengths of track circuits and transformer voltages, it would be a simple matter to measure the output of a certain track circuit and compare the output with a curve representing this particular track section, to determine the approximate joint resistance. In this manner insulated joints approaching the breakdown point could be discovered and removed before causing a failure.

The equipment is built as a compact unit.

[656. 225 (73) & 656. 261 (.73)]

Co-ordinated fast-freight handling system developed.

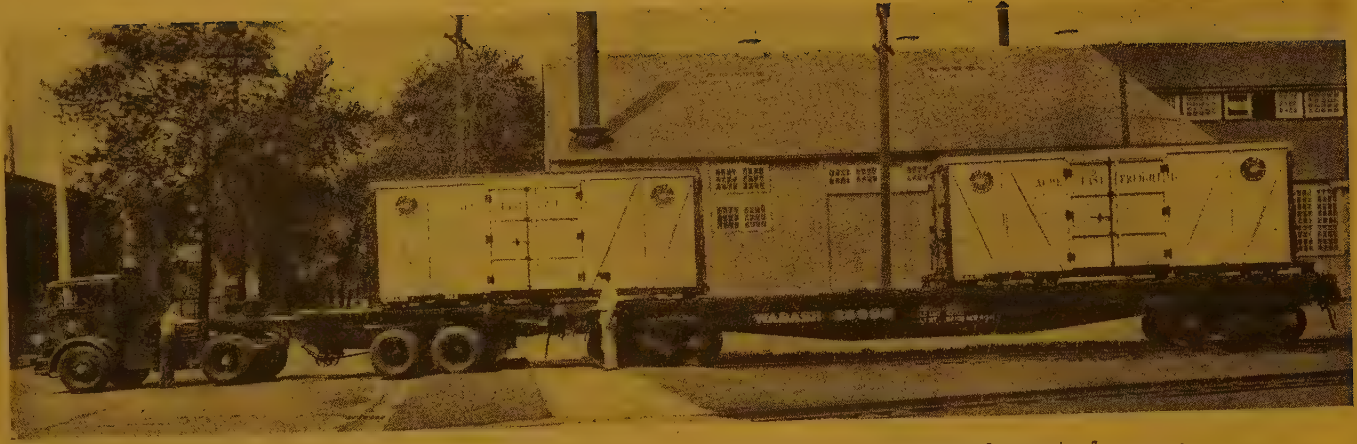
Special containers, rail flat cars and highway tractor-trailers for collection, rail transportation and highway delivery of freight.

(Railway Age.)

Two special shock-proof flat cars for the transportation of freight loaded in containers have been built recently by the American Car & Foundry Company, one for the Wabash Railway and the other for the Delaware, Lackawanna & Western Railroad. These cars were constructed in accordance with designs prepared by Wm. P. Kellett and are to be used by the D. L. & W and the Wabash in cooperation with the Acme Fast Freight, Inc., 88 Lexington avenue, New York, in order to determine the economic possibilities of a co-ordinated transportation service for car-load as well as less-than-car-load freight traffic.

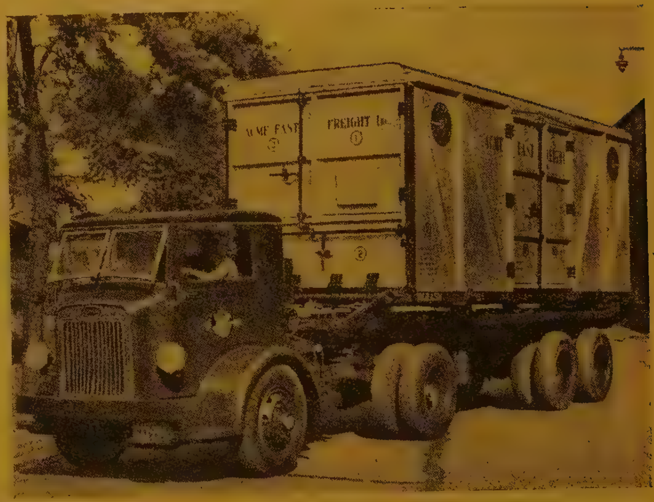
Shock-proof container car.

A specially designed 40-ton flat car is employed for the rail transportation of the containers. This car is not only



Transfer of containers between flat car and truck is effected without employment of a crane.

Sidewise transfer of containers may be employed if more convenient.



A special tractor-trailer with elevating platform is used for highway transportation of containers.

designed for receiving, fastening and transporting the containers, which are mounted on casters, but is also particularly noticeable for the provisions against damage to the lading or to the containers from shocks that may occur in yard or train movements. The car is 45 ft. 6 in. long over end sills and 9 ft. 6 in. wide, the truck centers being spaced 35 ft. 3 in. apart. As now constructed with ordinary carbon steel, its light weight is 52 100 lb., which gives a load limit of 83 900 lb. with 5-inch by 9-inch journal axles. However, by substituting medium manganese or other alloy steels having equivalent physical properties, this weight can be reduced by approximately 12 000 lb. The trucks have a wheel base of 5 ft. 6 in. and are equipped with the Barber lateral motion device and Miner spring snubbers. The draft gear is of the Miner selective travel type which provides 4 1/2 inches end movement.

The car underframe is of skeleton construction, the sills being of the fish-belly type built up of steel plates and angles. The center and side sills are tied together by the end sills, two bolsters, two crossbearers and three cross-ties.

Mounted on the underframe is a movable carriage or car floor, 4 ft. 1 3/4 in. above the rail with containers loaded. This is built up of 6-inch channels at sides and ends, four longitudinal Z-bars (two spaced close together on each side at a distance of 2 ft. 1 1/2 in. from the center line of the car) with eight transverse cross-ties made up of 4-inch angles and Z-bars, the whole being covered with 1/4-inch. plates on which are mounted guide strips for the container casters and various anchoring or retaining devices for securing the containers in transit. This carriage is carried on 18 side rollers, 3 1/2 inches in diameter, and 18 intermediate rollers, 4 inches in diameter, and spaced on lines 2 ft. 1 1/2 in. from the center line of the car. The rollers rest on short sections of track mounted on the underframe structure. These pieces of track are not level, but each one has a hump at the center directly under the rollers. The hump has an elevation of 1/2 inch above the balance of the track and is formed with a radius of 6 inches. Suitable retaining clamps are provided at the cross-bearers which tie the carriage and underframe together but permit free end movement of the carriage with relation to the underframe.

The body bolsters are quite wide — 27 1/2 inches — and are steel castings. In each bolster two heavy coil springs are mounted lengthwise of the car and in line with the intermediate carriage rollers. The springs have projecting followers and stops, the distance over the spring followers being 36 7/8 inches. The carriage or movable car floor is fitted with downwardly projecting stop castings against which the bolster spring followers are in contact. This arrangement permits the carriage to make a longitudinal cushioned movement of 4 1/2 inches each side of the normal transverse center line. Opposed to the movement of the carriage are the four cushion bolster springs referred to, each of which exerts a force of 36 000 lb. when fully compressed. The carriage rollers normally rest on the high points of the track, as already described. An end movement of the carriage with its load causes it to be lowered 1/4 inch, at which point a contact is made with 36 friction plates, this contact taking place at one-half the full endwise movement. The springs, in order to return the carriage to its normal central position, are thus obliged not only to take care of the longitudinal displacement, but also to raise the load. This arrangement is said to eliminate hunting action of the springs.

Containers carefully designed.

The containers for dry commodity freight are of the covered box type, having an inside width of 7 ft. 4 in., a length

of 20 feet, a height of 7 ft 4 1/2 in., and 1 047 cu. feet capacity. They have a light weight of 5 650 lb. and are stencilled for a load limit of 25 000 lb., which applies only when the containers are to be transferred for highway transportation. Should the car with its containers be utilized as an ordinary box car and unloaded without removal of the containers, the permissible axle loading applies. With containers of this design each could then be loaded with 36 300 lb. of freight. Two containers constitute a car load. The containers are of pressed-steel frame construction with plywood sides, ends, roof and subfloor, the actual floor being 13/16-inch tongued and grooved lumber. Hinged side doors are provided and each end can be opened for the full area by means of two hinged doors and a drop tail gate.

Each container is mounted on eight casters of the double roller, swivel type, in two rows, each 2 ft. 2 1/2 in. from the center line. The two casters on the door ends are linked together so as to form a steering device for use when transferring the container on or off the car.

After the containers have been moved into place on the car they are secured at each corner by buffer anchors — the center ones being double ended to hold the ends of each of the two containers, while the end anchors are fitted with screws by means of which the clamping may be made rigid. These anchor housings may be folded down and covered by pieces of hinged plate and thereby obtain a flush floor while the containers are loaded onto or off the car. Auxiliary side locks are also provided.

Tractor-trailers.

For road transportation of the containers especially designed tractor-trailers are employed. The trailer is fitted with an elevating platform, either or both ends of which may be raised or lowered by means of hydraulic cylinders to secure the easiest transfer of the containers between car and trailer. Suitable clamping means are provided for securing the container to the trailer. The tractor or motor has a winch and cable for transferring the containers. Normally the transfer takes place by rolling the container endwise from car to trailer, or vice versa. It has been found that a container may be thus transferred in less than one minute. If desired, however, the tractor-trailer may be spotted at the side of the car and the container transferred by being rolled off sidewise. This method of unloading is not quite as simple, but may be completed in from three to five minutes.

RECENT DEVELOPMENTS.

IN RAILWAY PRACTICE.

[625. 232. (.42)]

New first-class electric restaurant cars for the London and North Eastern Railway Company.

Two new first-class electric restaurant cars for service between King's Cross and Scotland have recently been completed at the Doncaster Works of the London & North Eastern Railway Company to the designs of Mr. H. N. Gresley, the Chief Mechanical Engineer.

Each car has an overall length of 63 ft. 6 in., and is carried on two 4-wheeled compound bolster 8 ft. 6 in. wheelbase bogies.

The bogies and underframes are built entirely of steel and the vehicles are fitted at each end with the standard arrangement of automatic buckeye couplers and Pullman vestibules.

The bodies are made of teak and finished externally in the natural wood, varnished. Each vehicle consists of a dining saloon to seat 18 persons, a pantry, kitchen, attendants' compartment and a toilet compartment.

The interior decoration of the saloon has been carried out by Messrs. White Allom & Co., London, and has been designed with a view to making the internal dimensions appear as large as possible.

The vertical lines of the wall panels and door surrounds have been designed with a view to carrying the eye up to the cornice. This has been placed considerably higher than is the usual practice, with the object of gaining a strong horizontal line where the ceiling apparently meets the wall. In actual fact the cornice is fixed some way up the curve of the ceiling, the whole arrangement being so designed as to disguise this fact. The illusion of height is still continued by the treatment of the overdoors which, instead of being square at the head, are now made to follow the curved line of the ceiling, enabling the door itself to be of an increased height.

The scheme is a pleasing arrangement of panelling unassuming and forming a restful atmosphere, the detail of the decoration tending towards the modern, but of a subdued nature. The carved motifs surmounting the doors carry the monogram of the Company.

The two coaches, although similar in scheme, are entirely different in their colour treatment; the one being in tones of old rose and beige, the other in pastel blue and stone, the colours being carried through the curtains, chair coverings, and carpet.

Each passenger is provided with an independent armchair, the chairs being quite a new departure in railway equipment. They are of the wing easy type in which every point has been studied for the traveller's comfort, both for ease in dining and relaxation. The chairs are covered in tapestry.

The lighting scheme is mainly indirect, the lamps being concealed behind the window capping which also carries the pelmet. The ceiling receives the light thrown from the concealed reflectors and diffuses it. The pelmet also incorporates a direct lighting fitting to light the table.

The floor in the saloon is covered with a Wilton carpet over sponge rubber.

The body side windows are fitteld with a louvre type of ventilator which automatically extracts vitiated air from the saloon while the car is in motion. An exhaust fan is also fitted in the ceiling. A steam heated radiator runs along the bottom of each side of the dining compartment.

All the cooking in the kitchen is carried out by means of electricity. The main cooking range is fitted across one end and comprises a roasting oven, steaming oven, grill and hot water boiler. A boiling range with six hot plates for frying and boiling, and a 10-gallon capacity boiling pan for cooking vegetables are also provided.

A hot cupboard situated on the corridor side has sufficient capacity for heating the whole of the plates, etc., required for the service and the top of this forms a convenient table.

Two 2-gallon urns are available for boiling water for teas and to supplement the supply from the boiler in the stove.

Two 47-gallon tanks for warm water, each having heater elements below, are fitted in the roofs of the corridor alongside the kitchen and from these tanks the water boiler and urns are filled.

The control of the cooking equipment in the kitchen is arranged as conveniently as possible for the chef.

A throw-over switch on the main switch board enables the load to be changed over from the pre-heating supply at the terminal station to the self-contained system which is brought into use when the car is running.

Each important element of the apparatus carries a separate switch indicated by a pilot lamp.

A mechanical refrigerating plant is provided which serves both pantry and kitchen.

The necessary electrical energy for operating the cooking apparatus whilst the car is in motion is provided by two 7-kilowatt generators, supplemented by a battery of accumulators to enable the cooking operations to be continued whilst the car is stationary.

The total weight of the vehicle is 44 tons.

MISCELLANEOUS INFORMATION.

[625. 245 (.492)]

Welded steel hopper wagons.

(*The Railway Engineer.*)

Fig. 1.

For conveying the coal traffic from the Netherlands State mines in Limburg, some lightweight all-welded hopper wagons have recently been built at the Utrecht shops of Werkspoor N.V. They consist of twin containers detachably mounted on underframes. The containers are loaded with coal in the usual way and, when the wagons reach their destination, they are lifted off the underframes by means of cranes, the hooks of which engage a pin at each end of the longitudinal centre line of the wagon. These pins form hinges joining the two

Fig. 2. — Welded steel hopper wagons under construction in the Werkspoor shops.

halves of the containers which are normally kept together by their weight. The lifting crane, however, is provided with two extra slings which are attached to the short bar in the middle of each side wall, and when these slings are tightened the two halves separate and the contents fall out.

The cars are entirely arc welded, not a single rivet being used in their construction. The usually unavoidable process of straightening out was virtually eliminated by slightly setting the parts in the opposite direction before welding was begun. Alternatively, certain parts were held rigid by means of heavy framing till the welds were cold. Following recent standard Werkspoor practice, every weld was laid in a horizontal position.

Over buffers the cars measure 7.90 m. (25 ft. 11 in.), and the overall height and width are respectively 3.01 m. (9 ft. 10 3/8 in.) and 3.11 m. (10 ft. 2 1/2 in.); the wheels are spread over a base of 4.60 m. (15 ft. 1 in.). The total capacity of the containers is 34 m^3 (1 200 cu. feet), equivalent to about 26 tons of coal, and each container scales 2 110 kgr. (4 650 lb.). As the weight of the underframe, wheels, and axles amounts to 6 870 kgr. (15 100 lb.), the vehicles thus tare 11 090 kgr. (24 400 lb.), or just under 11 tons.

NEW BOOKS AND PUBLICATIONS.

656. 2 (.43)]

Dr.-Ing. LEIBBRAND, Mitglied der Direktion, Deutsche Reichsbahn Gesellschaft, and Dr.-jur. H. DOMSCH, Reichsbahndirektionspräsident. — **Organisation und Durchführung des Betriebsdienstes und Verkehrsdienstes bei der Deutschen Reichsbahn** (*Organisation and working of the German State Railway Company*). — 1 pamphlet (8 1/4 × 6 inches) of 102 pages with tables and diagrams. — 1934, Berlin W. 9; Published by the Verkehrswissenschaftlichen Lehrmittelgesellschaft m. b. H. bei der Deutschen Reichsbahn. (Price : 3.65 Reichsmark.)

This pamphlet contains the text of two notes, by the authors, for the Fifth Annual Study Conference organised by the German Reichsbahn. The detailed description of the organisation of such an important railway system is of great interest to those professionally concerned with railways, and also to those who are connected with them either as clients or in some other way.

The authors have both dealt with their own side of the question, one with the organisation of the various services, and the other with the working (traffic). The former have to provide the equipment with which to carry out the transport of persons and goods with the greatest regularity and maximum economy possible, while the latter has to offer to customers all the transport facilities of the railway according to commercial principles.

The organisation is described in the first part, which covers, from the central management down to the last rung, all the factors concerned in running the trains, including also the design and construction of the stock, maintenance and repairs, stations, signalling, and communication equipment.

Te second part deals in a similar fashion with working the traffic, that is to say with the various operations concerned in carrying the traffic from start to finish. Very complete information is given about the structure of the rates.

For purposes of comparison, summarised information is given in the appendix on the organisation of some other railways.

In the appendices the authors have also included some valuable data particularly on the taxes on passenger rates (with the reductions justified by various considerations), on the respective amounts of passenger traffic carried at full and reduced rates, the division of the goods traffic among the various rating classes and categories, the composition of the stock of vehicles, etc...

E. M.

[385 .12. (.494)]

HAENNI (Joseph), Doctor of Laws, Notary of the Federal Post Office and Railway Department, at Berne. — **Les Concessions de chemins de fer en droit suisse** (*Railway Concessions according to Swiss law*). — One volume, in-8° (9 1/16 × 6 5/16 inches), of 140 pages. — Obtainable from the Author, 5, Engestrasse, Berne. (Price : 4 Swiss francs).

This volume is the thesis argued by the author before the Faculty of Law of the University of Berne, for his doctors degree. It is definitely judicial in character, and as such is likely to interest all those who have to deal with railway concessions from this point of view. At the same time, much information is given about Swiss railway legislation and on certain aspects of the evolution of the railway system in that country.

Chapter I gives a brief summary of the

legislation on railways, and in particular an analysis of the law of 1883 on the accountancy of the railway companies. This was intended to prepare the way for the repurchase of the concessions, the completion of which led to the present constitution of the Federal Railways.

Chapter II is devoted to a discussion on the judicial nature of the concessions.

Chapter III discusses under what conditions a *Federal* concession is necessary, lays down the procedure to be followed, and indicates the documents required to obtain it.

In Chapter IV, which is the most important part of the thesis, the author studies the various clauses of the *concession* deeds. He indicates the regulations laid down by the law as regards the control and supervision, and those contained in the act itself, the stipulations of a technical order, and those dealing with the operating regulations, the clauses about fixing the rates and submitting them for approval, and the various special obligations imposed upon the Companies. The question of repurchase is dealt with in some detail, as well as an examination of the various reasons which can cause the Public Authorities to put and end to the concession.

Among the *few particular questions* dealt with in Chapter V mention must be made of the discussion on the right of the Confederation to grant or refuse a concession, and the use it makes of this right, on the definition of the net profits, and also on the part played by the Cantons in granting concessions.

The Federal Railways are not affected by legislation on concessions. The right to build and operate new lines is given them by a special Federal law in the case of each line.

The work contains many references which make it possible to consult the sources, to follow the evolution of the concessions system, and to estimate the difficulties, such as fighting tendencies too inclined to favour a regional policy, which had to be surmounted in order to unify this important part of the legislation as regards Swiss national economy.

E. M.